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REPORT OF COMMISSION

ON

OCCUPATIONAL DISEASES

TO

HIS EXCELLENCY
GOVERNOR CHARLES S. DENEEN

JANUARY, 1911

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OCCUPATIONAL DISEASES

REPORT OF COMMISSION

His Excellency, Governor Charles S. Deneen.

Sir: The Commission on Occupational Diseases appointed by you has the honor to offer the following report:

I. The Joint Resolution of the Legislature and the Subsequent Acts.

The Commission was created by House Joint Resolution No. 16, Forty-fifth General Assembly, in the following terms:

Whereas, The limited time at the disposal of the present session of the General Assembly is insufficient to take up, much less consider carefully, the important subject of occupational diseases and diseases peculiar to the employment of persons in mercantile establishments, factories, mills, workshops, mining, railroading, electrical generating and construction; and,

Whereas, The health and safety of the vast army of employes in such establishments is of the most vital importance to the general security and prosperity of the commonwealth; and,

Whereas, It is well known that sickness, due to unwholesome conditions, is one of the chief causes of extreme poverty and distress, of the interruption of the use of costly machinery and other capital, of the destruction of the lives of the men whose energies in health are a source of wealth to the nation and the support of dependent families, and thus become the occasion of immeasurable moral misery in the dread of apprehended trouble and the sorrow of actual bereavement; and,

Whereas, It is well known that very much of disease may be prevented or diminished by suitable means and co-operation of an enlightened public; and,

Whereas, It is universally recognized as the moral duty of every civilized state to secure and publish information of vital importance to all citizens to promote safety and health, and to foster and regulate insurance against loss of income by accident and disease; there, be it

Resolved by the House of Representatives, the Senate concurring herein, That the Governor is hereby authorized and requested to appoint a commission of nine members to be composed of the State Factory Inspector, the secretary of the Bureau of Labor Statistics, the president and secretary of the State Board of Health, two reputable physicians and three other representative citizens of the State, who shall serve without remuneration, and whose duties shall be to thoroughly investigate causes and conditions relating to diseases of occupation, and to report

to the Governor the draft of any desirable bill or bills, designed to meet the purposes announced in this resolution, for consideration and action by the members of the Forty-sixth General Assembly.

Adopted by the House March 12, 1907.

Concurred in by the Senate March 20, 1907.

The Commission had not time after its appointment to conduct the investigation before the date named; therefore the Forty-sixth General Assembly continued its activity by House Joint Resolution No. 26, which provided:

"That said Occupational Diseases Commission so appointed by the Governor and it is hereby perpetuated, and the time given said Commission for its investigation is hereby extended until the next regular session of the General Assembly of the State of Illinois, at which time it is directed to make its report." (Session Laws, 1909, p. 488.)

The General Assembly, at its special session, by an Act approved and in force February 18, 1910, enlarged the purposes for which the fifteen thousand dollars appropriation made at the regular session might be used. (Page 77 Session Laws of Illinois for 1909.)

House Bill No. 730. Approved June 16, 1909.

AN ACT to provide for the ordinary and contingent expenses of the State Government until the expiration of the fiscal quarter after the adjournment of the next regular session of the General Assembly.

Sixty-ninth: To the Commission on Occupational Diseases, for printing, stationery, postage, telegraphing, stenographers, railroad fare and expenses of members of the commission, the sum of $15,000, or as much thereof as may be necessary.

II. The Work of the Commission.

The members of the Commission first appointed by the Governor were:

George W. Webster, M.D., President Illinois State Board of Health.
Charles Richmond Henderson, University of Chicago.
Edgar T. Davies, Chief Department of Factory Inspection.
Ludvig Hektoen, M.D., Memorial Institute for Infectious Diseases.
Arnold C. Klebs, M.D., Director Chicago Tuberculosis Institute.
James Simpson, Vice-President Marshall Field & Co.
James A. Egan, M.D.; Secretary Illinois State Board of Health.
David Ross, Secretary Bureau of Labor Statistics.
Alice Hamilton, M.D., Memorial Institute for Infectious Diseases.

Dr. Klebs resigned on account of residence abroad, and Dr. Alice Hamilton resigned in order that she might qualify as medical investigator. The Governor filled these two vacancies by appointing Dr. Walter S. Haines and Dr. W. H. Allport.

1. The full Commission held ten meetings.

2. The special sub-committee appointed by the Commission to have immediate charge of the investigation were: Dr. L. Hektoen, Mr. James Simpson and the Secretary, and they had frequent conferences.

3. The investigators appointed by the Commission were: On Lead Poisoning, Dr. Alice Hamilton, general supervision of investigation, assisted by the following persons working under her direction (Dr. Hamilton took for her special departments, lead, arsenic and mercury):

Dr. E. R. Hayhurst, assisted by Miss Anne H. Martin.—Conditions in brass foundries and examination of men for brass and lead-poisoning. Conditions in zinc smelters and examination of men. Examination of cases referred by investigators in the lead trades, in trades using turpentine, acetone, methyl alcohol, naphtha, benzine and allied substances. Analysis of dust from brass and zinc works and printing establishments. Experiments on animals to determine cause of brass chills.

O. F. Funkhouser, M.D., and T. E. Flinn, M.D., assisted Dr. Hayhurst in special cases.

S. M. Hartzmann.—Conditions in engraving, lithographing, advertising and picture post-card houses, in wallpaper factories, tailor shops, metal and junk shops, picture-frame factories. Examination of records in hospitals, dispensaries and trade unions.

W. P. Harms.—Conditions in the painting and printing trades and in the making of storage batteries.

M. P. Hunt.—Search for cases of known or suspected lead-poisoning in printers in collaboration with Dr. Hayhurst.

W. E. Nestor.—Examination of records of Painters' and Decorators' Union. Search for cases of known or suspected lead-poisoning among painters in collaboration with Dr. Hayhurst.

E. E. Watson.—Conditions in plumbers' trade. Search for cases of lead-poisoning among plumbers in collaboration with Dr. Hayhurst.

R. H. Nicholl.—Use of varnishes, varnish removers and turpentine. Search for cases of poisoning by these substances in collaboration with Dr. Hayhurst.

Miss Anne H. Martin.—Examination of records of fraternal organizations. Conditions in the artificial flower industry and in dry cleaning establishments in collaboration with Dr. Hayhurst.

Miss Myra G. Reed.—Cut glass.

Miss Nadina Moore.—Conditions in metal shops and in the glazing of pottery and tiles.

Dr. P. F. Becker.—Investigating the records of two hospitals for the insane.

H. J. Corper.—Brass founders' ague—experiments.

On Carbon Monoxide Poisoning: Dr. Walter S. Haines, member of the Commission, assisted by

Dr. Matthew Karasek and Dr. George L. Apfelbach.—Gas poisoning in steel works, in foundries, in tunnels and in tailor shops. Poisoning from cyanides, chromates, hydrofluoric acid. Study of conditions in foundries, in glass and mirror works and in photographic establishments.

Dr. Peter Bassoe.—Compressed air disease.

Dr. George E. Shambaugh.—Boilermakers' deafness.

Dr. Francis Lane and Dr. John B. Ellis.—Miners' nystagmus.

Mr. A. H. Hirsch made a trial exploration in respect to wood dust.

A summary of the methods and results of the medical investigators is printed as part of this report. Since these were scientific studies their authors are entitled to distinct and separate recognition, and to the right to publish any or all of their studies in scientific magazines for professional readers. All that can be used for our present purpose is embodied in this report.

4. The Secretary was authorized by the Commission: (1) to make contracts with the investigators, on advice from medical members of the Commission; (2) to keep accounts and pay bills as approved by the President of the Commission under the law and by the Auditor of State; (3) to study the legislation of various states and countries and the publications of scientific societies, so far as related to the objects of the Commission, and recommend to the Commission suitable measures for protecting the health and lives of the workers involved, whether further laws, improvements and administration, or practical warnings and counsels for shops where the workers are exposed to draught.

The Secretary was assisted at first by Mr. V. E. Helleberg and later by Mr. A. J. Norton, both of whom had legal training. They were faithful, industrious and efficient.

The University of Chicago placed a large hall at the disposal of the Secretary of the Commission, with light, heat and janitor service, without charge; gave the free use of its library and reading rooms, the time and strength of the Secretary, and many students co-operated without cost in collecting data.

The Memorial Institute of Infectious Diseases placed its facilities at the disposal of investigators, and Professor Walter S. Haines gave the use of his laboratory at Rush Medical College for chemical analyses.

The John Crerar Library and the Public Library of Chicago were generous in supplying books and documents and giving unstinted attention to the needs of the Commission. Their attendants and officers seemed to take genuine pleasure in promoting our labors.

The Bureau of Labor at Washington also gave desirable information and co-operated with the Commission in a study of the conditions of health in laundries. Professor E. Freund, of the Law Faculty of the University of Chicago. rendered important service by a critical examination of legal measures, and served without pay.

Mr. Samuel A. Harper, of Chicago, formerly attorney for the Industrial Commission, the Employers' Liability Commission, etc., of the State prepared the draft of the bill herewith presented. His services and experience were of great value to the Commission.

5. Each medical man on the Commission gave, of course without pay, personal attention to the problems before us and directed investigators in particular fields of inquiry, and tested their results, as indicated in the table showing the division of labor.

We herewith present summaries of the results of the different investigators, with indications of their significance and importance. It must be remembered that the Commission was in fact given only a little more than nine months for the actual examination of workplaces and workers. It was necessary to limit the investigation to a very few of the many fields which call for similar and even more extensive study.

While non-medical persons have been employed to collect some of the facts from written records or oral statements, no diagnosis of a patient has been set down without a professional examination of the person by a competent physician. When the statement rests on other kinds of evidence it is clearly shown in this report. Rumors and reports which could not be verified have been rejected. Therefore the statements made should be regarded with confidence as substantially correct.

The Commission in this report has been careful not to give names of firms and persons without their express consent. But the original notes of the investigators have been carefully preserved though kept from the public. The purpose of the Commission was purely scientific and humane and it gave careful instructions to all whom it employed to carry on their inquiries entirely in this spirit.

The Commission expresses its indebtedness for valuable information and advice to the following gentlemen:

Officials and members of—
Painters' and Decorators' Union,
Allied Printing Trades,
Electrical Workers' Union,
Plumbers' Union.
Mr. William Hoskins, Chemist, Mariner and Hoskins.
Professor Bleininger, University of Illinois.
Mr. Frederick Hoffman, Statistician of Prudential Life Insurance Company.
Mr. Edward Cornish and Mr. William Tolman, National Lead Company.
Mr. Frank Hammar, Hammar Bros.' White Lead Works, East St. Louis.
Mr. Charles Siepline, Sherwin Williams Company.
Mr. H. B. Brosser, Gates Potteries.
Mr. C. S. Miner, Chemist, Western Leather Laboratory.
Mr. Philip Elting, Adams & Elting.
Mr. Sidney Benedict, Paper Mills Company.
Mr. M. L. Barrett, 219 Lake street.
Mr. Howard Coonley, Enameled Wares, Clyde.
Mr. Holman, Royal Enamel Sign Company, Desplaines.
Mr. M. Bromberg, Fur Dresser, 1406 North Halsted street.
Mr. Clifford Dyer Holly, Chemist, St. Louis.
Mr. R. W. Evans, Picher Lead Company, Tacoma building.
Mr. Karl Kahmann, Taxidermist, 2457 Lincoln avenue.
Mr. William Dorflinger, Cut Glass, New York City.
Mr. E. R. Taylor, Manufacturing Chemist, Pen Yan, N. Y.
Dr. Wm. Burry, Illinois Steel Co.
International Harvester Company.

III. The Scope of the Field of Industrial Hygiene.

In order to show clearly the relations of the particular inquiries of the Commission, and to indicate the vast labor which remains untouched, we here outline and illustrate with all brevity the scope of industrial hygiene.

There are general principles of industrial hygiene which must be observed in all legislation, administrative rules and orders, and in

the customs of workplaces; and there are particular industrial poisons and sources of injury to health which require specific measures of protection.

The principles of industrial hygiene are derived from a study (1) of the causes of diseases found in the conditions of industry; (2) in the study of the best methods of diminishing or removing these causes, as shown by experience in all modern countries.

The causes of disease found in various occupations may be classified as follows[1]:

1. Vitiation of the atmosphere due to (a) the products of breathing; (b) irritating and poisonous gases and fumes; (c) irritating and poisonous dust; (d) infection carried principally by dust in the atmosphere.

2. Another group of causes may be traced to the nature of the material which comes in contact with the bodies of the workmen apart from contamination of the air, as irritating substances affecting the skin and producing eruptions, etc.

3. A third group of causes includes those due to the nature and condition of the trade process, as (a) the temperature of the shop, extremes of heat and cold; (b) extremes of dryness and humidity; (c) defects in lighting; (d) abnormal atmospheric pressure; (e) injuries from jarring, shaking and deafening noise; (f) danger from overstrain, fatigue, hurtful postures and overexercise of parts of the body.

In our preliminary report to the Governor and transmitted by him to the Legislature in a Special Message in April, 1909, we sketched in outline some of the dangers to which workmen are exposed. That outline was a demonstration of the necessity of a prolonged and thorough study of the whole subject with special reference to conditions in Illinois. It was, as we there said, impossible in a few months to compass this immense field. In order to offer more than mere superficial and worthless results we confined our attention to a few subjects in accordance with the unanimous advice of experts whom we consulted in Europe and America and in accordance with our own judgment of what would give the most reliable results.

For convenience we reprint here the tentative analysis of the general situation and a provisional estimate of the dangers to which many thousands of the employees in our great industries are constantly exposed.

"An analysis of the industries of our commonwealth, as exhibited in the report of the chief factory inspector, and of the diseases which the medical profession often find associated with these industries, will bring before any intelligent and competent citizen the vastness and complexity of the problem.

1. In *metal industries* we are informed that corresponding to the several branches of trade, certain diseases are found, due in some measure to the nature of the occupation.

1. Iron.—Blacksmiths and horseshoers are liable to hypertrophy of muscles, burns, inflammation of the eyelids, hernia, aneurism, bronchitis, rheumatism, palsy.

[1] In the main the outline of J. Rambousek, Lehrbuch der Gewerbe-Hygiene.

Steel workers are exposed to excessive heat and are liable to pneumonia, phthisis, disturbances of circulation, digestion and urinary organs.

Watch workers are exposed to lung troubles.

Workers in the manufacture of wire, tacks, and employees in railroad shops are liable to affections of the eyes, viscera, and nervous system.

2. Workers in copper are exposed to numerous dangers to health.

3. Painters, typesetters and all others who handle *lead* and its compounds, are liable to be poisoned, and in Illinois many thousands of employees seem to be exposed more or less to these perils.

4. There are apparently about thirteen hundred (1300) men who come in contact with *zinc,* which also acts as a poison.

5. We have no figures for the number of workers in *mercury,* but it must be considerable.

6. A large number of persons engaged in industries which involve tin and zinc plating. The chemicals used in some of these operations present peculiar perils.

7. The industries requiring the manipulation of chromatic arsenic, phosphorus, and aluminum should be carefully studied, as our information is vague and inadequate.[1]

II. Illinois has over fourteen thousand (14,000) persons employed in the manufacture of bricks, marble and other stone works, in glass works, and in other industries where the workmen are constantly exposed to lung diseases, lead-poisoning, sudden changes from heat to cold, with ensuing rheumatism and nervous disorders. Workers in glass are exposed to special forms of disease of mouth, lungs and eyes.

III. Turning to occupations in which the workmen are exposed to the dangers of dust, to the injury of lungs and general vitality, we know that a vast army of men and women risk their lives in occupations of this class. More than sixty-five thousand (65,000) men labor in mines; many hundreds in the manufacture of cotton and woolen goods; others in great numbers handle furs, hair, rags and mattresses and inhale dust with its bacteria.

Bakeries and mills are not free from conditions injurious to health. Workers in tobacco, coopers, woodworkers, carpenters, furniture men, carry to their physicians problems which originate in their place of work.

Carriage manufacturers are injured by paint and varnish.

IV. Leather Industries.—Tanners may be injured by diseased hides. Shoe factories show a great liability to consumption and nervous diseases. Workers in rubber goods are exposed to carbon bi-sulphide poisoning.

V. The paper industries have their perils which call for study.

[1] There is a careful study of phosphorus and making of matches in a Bulletin of the Bureau of United States Labor, by Dr. John B. Andrews.

VI. In the preparation of food more than forty thousand (40,000) persons are daily engaged in the most necessary social service with a certain exposure to sickness.

Thousands of workingmen in breweries and distilleries are exposed to conditions which make them bad insurance risks.

VII. The story of the clothing manufacturer recalls the pathetic "Song of the Shirt" by the sympathetic poet Hood, and more than sixty-three thousand (63,000) men, women and children in Illinois are engaged in this industry. The medical men tell us of consumption, anaemia, indigestion, and various ailments, caused by conditions under which they work. The study of these conditions and of measures for relief alone would require many months of expert investigation.

VIII. We need a satisfactory and authoritative investigation of morbidity and mortality in the chemical industries which are becoming every year more important. Gas, steam, chlorine, alkalis, sulphur, carbonic oxide, tar, cyanides, are employed in various industrial processes and may be dangerous to workers.

IX. The very useful and necessary manufacture of fertilizers and glue in connection with the production of meat supplies requires scientific consideration in relation to hygienic conditions.

X. The manipulation of wood, coal, petroleum, fats, varnish, and turpentine involves perils to health.

XI. The influence of certain industries on the neighborhoods in the production of impure air, polluted water, evil drains and unpleasant odors should be considered with utmost care.

XII. Closely related to industrial diseases in the strict sense are the effects of unhygienic habits and surroundings of the workers.

In some occupations the direct and demonstrable connection between the work and specific diseases is more manifest than in others. We may select those occupations which are included under the recent British Compensation Act, which requires employers to pay indemnity to workmen who have become sick in consequence of the nature of their work, although some of the diseases may be very rare in this country.

Anthrax is a disease caused by handling wool, hair, bristles, hides, and skins.

Lead-poisoning and its sequelae are found in connection with any process involving the use of lead or its preparations or compounds, as in making paint, or painting surfaces, or typesetting.

Phosphorus poisoning is found to be caused by any process, as match-making, where this substance in certain forms is used.

Arsenic is a dangerous poison and is used in several trades.

This was the list included in the British law, but the departmental committee on compensation for industrial diseases, after a long investigation, reported in 1907 that certain other occupations should be added as clearly causes of specific ailments. These were: Poisoning by nitro-derivations of benzene (dinitro-benzol, anilin, and others); poisoning by carbon di-sulphide; poisoning by nitrous fumes; poisoning by nickel

carbonyl; arsenic and lead-poisoning; poisoning by African boxwood; chrome ulceration, eczematous ulceration of the skin produced by dust, or caustic or corrosive liquids, or ulceration of the mucous membrane of the nose and mouth produced by dust, or epitheliomatous cancer, or ulceration of the skin, or of the corneal surface of the eye, due to pitch, tar, or tarry compounds; scrotal epithelioma, nystagmus, a miner's malady; glanders; compressed air illness; the miner's beat hand; the miner's beat knee, acute bursitis over the elbow (miner's beat elbow), inflammation of the synovial lining of the wrist, joint, and tendon sheaths."

List of Industrial Poisons.

A valuable document of the International Association for Labor Legislation is the ("Entwarf einer Liste der gewerblichen Gifte") list of industrial poisons, by Sir Thomas Oliver, M.D., Prof. Dr. Felix Putzeys and Prof. Dr. Th. Sommerfeld, Jena, Gustav Fischer, 1908. An English translation of this may be found in Bulletin of the Bureau of Labor No. 86, January, 1910. This list has recently been revised, but it is impossible to make one which will be exactly true of all countries or even of all workplaces of the same kind in a single state or city. From this bulletin the following paragraphs are condensed:

The dangers to which workmen are exposed in different occupations:

Poisons may enter the body of the workmen either through the mouth and digestive system, through the respiratory system, or through the skin.

Among the substances used in various industries which may injure health or even deprive of life are:

Alcohol, used in various processes of industry.

Alcohol, methyl, in manufacture of varnish, polish, preparation of dyes, etc.

Ammonia, as in gas works, refrigerators.

Aniline colors.

Antimony, in alloys, paints, glazes.

Arsenic, in chemical works, glass industry, artificial flowers, stuffing animals.

Arseniuretted hydrogen gas, as in treating iron and zinc with hydrochloric and sulphuric acid, soldering.

Benzene, in manufacture of rubber goods, cleaning clothes, dyeing.

Carbon dioxide, in any situation where combustion or decomposition occurs.

Carbon disulphide, in extraction of fats, vulcanizing india rubber.

Carbon monoxide, manufacture of iron, steel, smelting furnaces, brick workers, coal mines, heating with open coal pans, chemical laboratories.

Chloride of lime, bleaching establishments, chemical works.

Chlorine, laundry work, bleaching.

Chromates, in tanning, steel corrosion, photography, mordants, dyes, matches.

Dinitrobenzene or binitrobenzene, in the manufacture of explosives.
Formaldehyde, in disinfection, manufacture of tar dyes, preservation of organic compounds.
Hydrochloric acid, in chemical works, enameling, soldering, bleaching.
Hydrofluoric acid, manufacture of glass, glass etching, superphosphate industry.
Lead, in many combinations, in reducing the ores, in manufacture of sheet lead, pipes, alloys, shot, printing, colors, painting.
Nitrobenzene, in tar dyes.
Manganese, in chlorine industry, preparation of oxygen, coloring glass, dyeing, lacquer, varnish, oil paints, charging of galvanic cells.
Mercury, in extraction of gold and silver, gilding, bronzing, filling thermometers, manufacture of felt hats, photography.
Nitrous gases, in chemical works, celluloid works, aniline dyes, etching of metals, electro-metallurgy.
Phosphorus, in extraction from bone ash, making of matches, tar dyes.
Picric acid, in chemical works, explosives.
Hydrocyanic acid, in preparation of certain organic compounds, electrotyping, photography.
Pyridin, in denaturation of spirits.
Sulphur chloride, india rubber industry.
Sulphuretted hydrogen, sewer work, water closets, coal gas manufacture, making of certain colors.
Sulphurous acid, in roasting of sulphur ores, manufacture of sulphuric acid, bleaching, candle making, brick works, manufacture of glue.

Until we have thoroughly studied all the industrial processes in our state we cannot tell how many of these poisons are actually in contact with workmen; many of them we already know are sources of sickness, pain, disability, death. The list shows how vast is the field for such inquiries.

Means of Alleviation.

The preventive measures must correspond to the nature and the causes of disease. Many of the most important causes of disease are due to contamination of the air, and the remedy is found in adequate methods of ventilation.

So far as the unwholesome conditions of the shop are not due to contaminated air they may be diminished or removed by avoiding contact with the irritating substances; by cleanliness of shop and clothing and person of the workmen, etc.

So far as the diseases are caused by other external conditions just classified above the methods of prevention will be found in the removal of the evil conditions and by the discovery of technical processes or machinery which do not require these dangerous conditions.

While these general principles are applicable to a wide range of industries, and may serve as the basis for the general law of factory inspection, they must be applied in detail to each particular industry and to each particular kind of industrial poisoning in accordance with the nature of the case. Thus, in addition to the ordinary principles of

ventilation and cleanliness we must have special measures and rules governing the conduct of shops where lead, arsenic, cyanide of potassium, mercury, or other specific poisons may be introduced into the body either by respiration or by outward contact. It is always a difficult question to decide how far these specific regulations shall be embodied in statutes and how far they may be left to administrative bodies or officials.

The recommendations we have to offer are embodied, in accordance with our instructions, in the draft of a bill, herewith transmitted.

IV. Principles of Effective Legislation for the Prevention of Diseases of Occupation.

1. The law must provide for assuring the general conditions of health in workplaces, as ventilation, cleanliness, freedom from overcrowding, proper temperature and humidity, drainage, sanitary conveniences, etc.
2. The law must provide special measures of protection on account of the greater susceptibility to disease of children, youth and women.
3. There are recognized specially dangerous and unhealthy industries, which must be brought under special kinds of regulation.
4. The law must provide suitable organization of administration to make it effective.

The law under which the inspectors are authorized to inspect and order changes in shop arrangements must be expressed in general terms. It should include only the essential principles of industrial hygiene, and must leave many points to be interpreted by some authority. Such phrases as "as far as possible" or "reasonable" must be applied in particular cases by some legal authority. Primarily this authority is the factory inspector, and where there is no dispute his decision is final, but where there is a dispute about the interpretation of the law as applied to the particular situation, the factory inspector is empowered to carry his ruling before the proper court. The court will interpret the law according to the information which it possesses. Necessarily, the decision, whether made by an administrative or a judicial authority, requires information in regard to the technique of the particular branch involved, the dangers to which its workmen are exposed, and the methods of protecting health. This will vary with each department of industry, and therefore it is necessary to provide information not only for factory inspectors, courts, and arbitrators, but also for the employers themselves and the workmen. Such information must be modified from time to time by changes in the nature of the process brought about by innovations and improvements in machinery and in organization of shops. This report contains some forms of information which may serve to illustrate the value and importance of the subject, but it is manifest that to meet the constant changes the state must have some administrative agency equipped with training for studying the best methods of prevention and of furnishing instructions in proper form.

The advantage of making a law as full of details as possible for particular occupations is that it makes known to the employers and

manufacturers precisely what their duties are and preserves them from capricious action of inspectors. Manufacturers are naturally unwilling to be subjected to the caprice of inspectors and desire to know in advance how far the inspectors have power to control their business.

On the other hand, there are important advantages in giving considerable latitude to the administration, even from the standpoint of the manufacturer. The conditions of various industries and workplaces vary considerably, and it is desirable to adapt methods to particular circumstances, which can be done if there is an administrative agency with some freedom of choice in regard to methods, machinery, devices, etc.

In countries where social insurance is legally organized, as in Germany, many of the points in dispute are readily settled by committees composed of representatives of both employers and employees, who have the advice of expert medical officers, and who are all interested by their common participation in the costs of insurance, in making preventive devices as perfect as possible. The manufacturers and the workmen know more about the difficulties and dangers of their particular branch and of the particular shop than any outside officials can possibly know, and they are most directly interested under a good system of insurance, in reducing the costs of accident and disease to the minimum. But we must wait a while for this.

A medium ground must therefore be discovered between a law which enters into minute details and a statute which is too vague and general to have much value for particular trades.

Much might be done to reconcile these contradictions by making the law as complete as is consistent with the nature of the general regulation and then to supplement the general statute by regulations for specific trades and by orders of a competent administrative body. The tendency in this country is in the direction of providing in the administration for a variety of new conditions; but we are compelled to recognize constitutional limitations.

But even short of legal and administrative rules much can be accomplished by the wide publication and posting in shops of the dangers attending particular processes of manufacture and the best means of preventing injuries.

V. Scope of Administration.

At present it may not be wise to change very much the present machinery for enforcement of the laws of our state relating to the health, safety and comfort of employees. Already honorable advance has been made in this direction by our office of factory inspection; although the staff should be greatly increased and should be strengthened by the addition of medical inspectors and specialists in various branches of engineering. What we have to propose for present action is put in the form of bills for the consideration of the Legislature.

Perhaps the time will come in Illinois when, as in the older countries of larger experience, we can have a genuine labor code, into which shall be brought in logical, clear, intelligible form all the legal regulations

affecting the well-being of our army of employees in mines, mills, factories, workshops, and mercantile establishments.

Some of the members of the Commission wish to have this thought brought to the attention of the public at this time, although these members do not suggest immediate action of a radical nature.

But even the fragmentary additions to the present laws which we do suggest ought to be considered in relation to the gradual and careful development of a large public policy which can go forward with steady experiment and criticism. A contribution to the development of such a policy is given in the form of propositions on legislation and administration in the field of industrial hygiene which will be found in the appendix to this report. The necessity of having a labor code, with an efficient and trusted agency to administer it, arises first of all from the amazing energy, initiation, and inventiveness which characterize contemporary industry. Millions of competitors vie with each other in the discovery of new and better methods of production. In their laboratories the students of physical science are daily revealing to the practical world hitherto unknown qualities of matter and force, new combinations of chemical reactions, and inventors follow closely on their tracks, showing the immediate use to which such discoveries can be put. To regulate the use of these new forces and methods so that human beings shall be served and not destroyed by them requires constant modifications of law and rules. Just as scientific textbooks are rubbish in ten years and fine machines are scrapped before they are half worn out, so laws soon become obsolete; yet, unless we fall into anarchy and misrule, we must learn to make laws and live under them and apply them to a progressive world. The same changes wrought by discoveries, invention and managerial genius require a board of state administration which can daily watch the process and meet emergencies as they come.

VI. Recommendations of Rules, Posters, Forms of Instructions and Warning by Trades.

Many cases of illness, disability and death are due to ignorance of facts and causes; and the employers and workmen would be able to prevent much suffering if they were put in possession of the results of modern scientific study. We have, therefore, printed as a part of this report some of the forms whose use may diminish these dangers. Provision should at once be made for preparing other similar instructions for various branches of trades.

VIII. Trade Risk and Sickness Insurance.

This subject is included in the joint resolution by which the Legislature created this Commission, as cited above.

The facts brought out in our investigation leave no reason for doubt in respect to the reality of what has been called the "risk of trade"; by which is meant a danger to health which still exists in some degree after all known precautions have been taken both by employers and employees. Our expert investigators came upon many examples of this risk. No

doubt the progress of medical science and of mechanical invention will remove some of the present factors of peril, but not all; and the increased activity and energy of productive enterprise, spurred by competition and by demand for dividends, will in many directions introduce new perils to life and health.

Under present laws in the United States this risk is borne chiefly by the injured workmen, while in all other nations which profess to be civilized this risk is treated as part of the cost of production and in the cost of compensation or insurance is levied on the consuming public through the employers.

This truth is in part already recognized by some of the larger and more enlightened corporations which provide hospital care, first aid, and sometimes slight indemnity at their own cost and charges. What the most advanced employers do voluntarily is an admission that it ought to be done thoroughly, legally, and by all employers.

As not all sickness is caused by injuries in the occupation, though all disabled men need insurance, whatever the origin of their temporary or permanent unfitness for work, the premiums for sickness insurance should be paid partly by the workmen and partly by the employers. In Germany the former pay two-thirds of the premiums and the latter one-third; but after the fourteenth week of illness the employers pay *all* the cost of insurance when the disability is due to occupation. In the British Compensation Act a certain number of occupational diseases are treated as if they were accidents and the employers are legally obliged to pay a certain definite compensation; therefore they insure themselves in casualty companies to cover this risk and provide a fund for payment of indemnities. Other countries have still other methods, but all admit the principle.

An essential part of a scheme of protection must include social insurance legislation and a system of legally obligatory insurance working automatically to prevent both accidents and diseases, as is demonstrated by European experience for a whole generation. The organization for such a system and laws necessary for its basis should be the subject for the study of a special commission.

In connection with the subject of sickness insurance we may cite the evidence furnished by the Board of Commissioners of Cook County, Illinois. In a report given out by them on September 20, 1910, they say:

"Section 1. Increase of Hospital Population.—We find that the hospital (that is of Cook County, public charity) is greatly overcrowded. In 1903 the daily average was 835; in 1908, five years later, it was 1303, showing an increase of 56 per cent in daily average population. During the last year the daily average was 1451. This increase is due to a number of causes: (1) The increase in the population of the county; (2) the *extension of industrial pursuits which resulted in an increase of accidents and occupational diseases endangering human life;* (3) the popularization of the hospital idea."

In Section 6 of the same report this board recommends a bond issue of three million dollars for the construction of five new buildings to meet the increased demands.

This evidence is in accordance with the experience of older countries with their extended systems of sickness and accident insurance, and the statistics carefully kept for this purpose. These statistics show that sickness is a far greater cause of disability of workmen than industrial accidents.

Where statistics have been kept in this country the same fact is made apparent.

IX. Recommendations as to the Continuation of the Study of Occupational Diseases in Illinois by This or a Similar Commission.

Such a commission should have two years and not less than $30,000 for its necessary expenses.

We have in this report furnished abundant facts to demonstrate both the necessity and utility of such further investigation. While we have pushed this inquiry as far as was possible in nine months, consistently with rigid economy of funds and thoroughness in method, we have covered only a relatively small part of the field already outlined above. Justice to the public health and welfare and to the workmen in other occupations demands a continuation of the investigation which we have only begun. Every great modern industrial state has acknowledged this obligation. It is a public and not a merely class interest.

Such an investigation is required—

1. To furnish to the medical profession the facts which they need for their guidance in the prompt discovery of the industrial causes of many diseases. A treatment of symptoms which ignores the shop conditions and the gradual and insidious introduction of poisons into the body is likely to fail.

2. The knowledge thus acquired will be useful to employers of labor. We here assume that no reputable manufacturer will deliberately plan to poison or kill those who are in his service. But we have already abundant evidence that employers are actually keeping workplaces in conditions which must inevitably result in sickness, weakness, pauperism, death, and sometimes better means are known which would remove at least part of the danger.

A manufacturer makes his best profits with good tools, instruments, and skill. In several places known to us the workplaces are so injurious to health that the workmen are compelled to leave after a few weeks or months, after skill has been acquired and their labor is of the most value. This is a source of loss which, in great degree, can be reduced by wise measures. Further research will reveal many other similar situations.

4. The burden of the diseased, crippled, and disabled workman finally falls on the community; and the community in self-defense must inquire in a scientific way for the causes of that burden to learn how to diminish its weight.

5. The employees in manufactories and their families are vitally interested in this whole matter. With them it is not merely a question of more or less money, but literally of life or death.

A policy of concealment and of obstinacy in wilful ignorance is a folly unworthy of our noble commonwealth. The whole people is concerned when any group of its membership is exposed to disease. It is to the direct, immediate, and permanent interest of all citizens that evil and harmful conditions shall be brought to light, that workmen be taught their dangers and how they can best protect themselves from injury, that enlightened and considerate employers shall be enabled to introduce the best protective devices and methods, and that those who wilfully ruin the bodies of their fellow-men shall be exposed and compelled to change their ways.

But such a constructive, protective, far-sighted public policy cannot be initiated and sustained without a broad basis of facts ascertained by a thorough investigation in the hands of competent investigators, who have special training and experience in this kind of inquiry. While your Commission and its corps of assistants have devoted themselves to this study, they most of all realize how little can be accomplished in so short a time; so short that it was impossible even to put in shape for publication more than a small part of the facts which they have discovered. Two full years would yield far more satisfactory results, and the people of Illinois would be spared much pain and loss, and all would gain in wealth, health, and happiness for the expenditure of the necessary time, money, and labor.

Signed by

GEORGE W. WEBSTER, President.
CHARLES RICHMOND HENDERSON, Secretary.
EDGAR T. DAVIES.
LUDVIG HEKTOEN.
JAMES SIMPSON.
JAMES E. EGAN.
DAVID ROSS.
WALTER S. HAINES.
W. H. ALLPORT.

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[1] The following letter from the Department of Health, Chicago, is one more indication of a rich storehouse of recorded materials, which ought to be studied for the public benefit:

PROF. C. R. HENDERSON, *Secretary:*

Replying to your letter of December 12th, will say that the statement of occupation on our form of death certificate is arranged in such a way as to enable us to collect data of vital importance.

In it we ask for the last occupation—(a) profession, trade, or kind of work, (b) industry or business, and the year from which to which so engaged; also former occupation and industry, and the year from which to which so engaged, so that by comparison with the duration of the disease, the occupation in which the individual was engaged at the time the disease was contracted may be determined.

This also shows the occupations that have changed within five years prior to death. Thus we have a rational statement of the occupation causing death, rather than the occupation to which the individual was driven by nature of disease or injury.

Unfortunately we have not had sufficient clerical help to make these tabulations. I am, therefore, unable to give you the results of the information so collected, but I hope your Commission will continue and that you may have an opportunity to make a study of this valuable data.

Yours very truly,

December 15, 1910.

M. O. HECKARD, M. D.,
Registrar of Vital Statistics,
Department of Health, City of Chicago.

II. REPORTS OF INVESTIGATORS.

I. Report of Dr. Alice Hamilton on Investigations of the Lead Troubles in Illinois, from the Hygienic Standpoint.

Lead is by far the most important of the industrial poisons. First, because it has a far wider use than any other, and secondly, because it is an insidious poison, being absorbed little by little and accumulating in the system, where it remains a long time, and is very slowly got rid of. Repeated doses, each one so small as to cause no discomfort at all, end by piling up a quantity sufficient to cause a severe attack of poisoning. Even as little as one-sixth of a grain a day is enough, according to certain German authorities. This partly explains why lead-poisoning is so common and also why the symptoms develop so unexpectedly. Many investigators here and abroad during recent years have been studying the question of the absorption of lead by the human body, and it is now practically proved that absorption takes place chiefly through the alimentary tract, sometimes through the vessels in the lungs, but probably not at all through the skin. Lead reaches the stomach by means of food or tobacco that is handled with dirty fingers, or by the breathing of dust-laden air, in which case the lead is partly swallowed and partly carried on to the lungs.

There is an enormous difference in the susceptibility to lead-poisoning of different individuals. We have had cases in painters who have worked for thirty or forty years without apparently suffering from the lead and have then developed a typical attack of lead-poisoning. In some instances it was an acute disease that broke down the resistance of the body to the poison which it had absorbed. On the other hand, many cases have come to us from lead smelting establishments, white lead works and storage battery works in which the symptoms of lead-poisoning developed in less than two months' time. The most rapid case we have found was one man who showed poisoning after three days' work in a white lead factory.

The symptoms of lead-poisoning are loss of appetite, foul breath, indigestion, headache, and constipation; then, usually, an acute attack of colic which is often very agonizing. The man recovers from this attack, and if he does not return to work he may show no permanent effects, but if he does continue in a work which exposes him to lead, he probably will become a victim of chronic lead-poisoning with an occasional acute attack of colic. The chronic poisoning shows itself in extreme paleness, loss of weight, indigestion, constipation, rheumatic or gouty pains. There is a slowly increasing disease of the blood vessels, liver, kidneys and heart, so that death usually comes as a result of the secondary effects of the poisoning rather than during an acute attack of colic. The effect on the nervous system usually comes later, though sometimes it appears very early in the history of the case. The most common result is a paralysis which appears in the muscles which have been most used, although later paralysis may be general. Thus the commonest form is the "wrist drop," but there are also instances of weakness of the muscles of the shoulders or ankles. In other cases, the nerves of the eye are effected and blindness results, temporary or permanent, or there may

be epileptic attacks, insanity or fatal convulsions. Opinions differ as to whether every acute attack of lead-poisoning leaves serious or permanent effects. Some physicians think a man can have perhaps two attacks without permanent damage to his organs, but hardly more than two. Others believe that even one attack leaves traces in the liver and kidneys.

The compounds of lead are dangerous in the following order, depending upon their solubility in the human body:

1. Sugar of lead, which is used in dry color works and in the making of sanitary supplies, and in colors for textiles, etc.; although this is the most soluble, it is really not as dangerous as white lead, because its decidedly disagreeable taste prevents it from being swallowed in any quantity.

2. White Lead.—In white lead factories, dry color and paint works and wherever paint is used, also in some pottery glazes and enamels, in the coloring of wallpapers and textiles, etc. It is almost as soluble as sugar of lead and has a faintly sweetish taste.

3. Lead oxide and sub-oxide, which comprise the fumes and the skimmings wherever lead is melted. It is nearly as poisonous as white lead, especially as the fumes from melted lead are very finely powdered and thus are easily breathed in. Some authorities consider it more dangerous than white lead.

4. Red lead and litharge, which are found in red lead factories, in storage battery works, in dry color and paint houses, in the glaze of potteries, enameled signs and sanitary supplies, and in the making of rubber.

5. Chrome yellow and green, which are used in dry color and paint houses, for painting, for dyeing textiles, artificial flowers and wallpapers. This is about as poisonous as red lead.

6. Metallic lead and the other salts of lead are less dangerous, because so much less soluble, but in the case of metallic lead, a fine coat of oxide is continually forming on the surface and this is easily blown off or comes off on the fingers so that lead-poisoning occurs occasionally even in places where the lead is not melted but only handled in solid form. It is, however, more frequent when the lead is present in molten form. There is a general impression that melted lead is not dangerous at a low temperature, because it does not volatilize under 1000° C. The danger from melted lead is not only, however, that the lead may be volatilized, but that the film of oxide which is continually forming on the surface of the liquid lead blows off whenever the liquid is disturbed.

Of the men employed in lead industries in Illinois, part are skilled workmen who speak English, part are unskilled, newly arrived immigrants, or negroes. Among the skilled lead workers are the commercial artists of whom there are over 500 in Chicago alone engaged in making catalogues, pattern books, etc., and who use white lead paint in such a way as to be exposed to lead-poisoning. Skilled workmen are also found in the painting trade, the printing and plumbing trades, although these last two do not yield nearly so much lead poisoning as formerly, owing to radical differences in method developed of late years. There are also skilled workmen in parts of the lead smelting industry, in the making of lead pipe, lead wire and tubing, sheet lead, tinfoil, etc., and as foremen in all factories. Unskilled foreigners and negroes form the mass

of the workmen in the white lead works, in the smelting works, the making of dry colors, part of the painting of cars and agricultural implements, and also among the workers in factories where picture frames, car seals, coffins, storage battery plates, are made, and in the sorting and melting of junk and in brass foundries.

The protection of workers in lead against poisoning must follow two lines, first, the prevention of dust, and second, provision for the care of the men's persons; in other words, the workmen must not be exposed to air filled with lead dust nor must they eat with face and hands unwashed nor go home with lead on their clothes and bodies. The presence of food in the stomach is a great safeguard. Nothing is worse than starting work on an empty stomach, as many foreign workmen do who have the habit of breakfasting two hours or so after they have begun work. Milk is an excellent preventive. Tobacco chewing, which we find is generally encouraged by American foremen and managers, is forbidden in all European factories where lead is handled. The risk of carrying lead into the mouth with the tobacco is great and the advantage which is claimed by the advocates of chewing tobacco, namely, that the constant expectoration clears the mouth of lead dust, is of very problematic value. The plug of tobacco is kept in the lead powdered working clothes, is handled with lead-smeared fingers, and passes often through a lead-powdered mustache to the mouth.

In order to abolish dust there should be a lavish use of water wherever this is possible, and a system of suction fans wherever the process makes the use of water impossible. In processes necessarily dusty the men should be obliged to wear some form of respirator, as light and little bulky as possible. A simple muslin respirator does perfectly well. No respirator, however, must be looked upon as completely protecting a man working in dust, and therefore these men should be watched, and as soon as they show signs of absorption of lead they should be shifted to safe work, a proceeding that is perfectly possible in most lead works in Illinois, where the great majority of employees are unskilled.

For the proper care of the men's persons it is not enough to provide lavatories with hot and cold water. Soap, towels and nail brushes must be provided too, and baths for all men engaged in very dusty work. The washing before lunch and the washing or bathing before quitting work must be made a part of the shop discipline, violation of which results in a fine or discharge. The Illinois law provides that a separate room for meals should be found in all these factories and that workmen should not be allowed to eat in places where there is lead dust. It would be well if there were in such rooms a stove, where the men could heat their food. It would also be advisable to allow time in the morning for the men to wash and to eat their breakfast, because European workmen are accustomed to this and are often found eating bread or sandwiches in the middle of the morning while at work, with lead-covered hands.

It is impossible to prevent a man from carrying home on his person lead dust, unless he is made to leave his working clothes in the factory. He must be made to change into overalls when he goes to work, and if the employer does not provide and wash the overalls, he should oblige

his men to do so. Some form of head-covering should be worn by all the men engaged in dusty work, and it should never be worn outside the factory.

All of these measures are in force in England at present, and although at first it was supposed that the employees would refuse to submit to them, the experience of more than twenty years has proved that they are perfectly practicable.

The skilled, English-speaking workmen in the Illinois lead works usually understand that the trade they are engaged in is dangerous, but they do not know much about the dangerous features or how to avoid them. They become reckless from familiarity with danger and need constant watching and warning. In every establishment where lead is used the workmen should be made thoroughly acquainted with the proper means of guarding themselves against poisoning. Especially is this true of the unskilled foreigners who enter upon the work utterly ignorant of its dangers or with only a vague, unintelligent dread. These are the men who furnish the most serious and rapid cases of lead poisoning to the hospitals. For instance, a young Bulgarian went to work in a white lead factory the first week he arrived in Chicago, and was put to emptying pans of dry white lead. He was given no respirator and had no idea that he had a right to ask for one. Nobody told him the white dust on his hands and mustache was poisonous. He had only one suit of clothes and wore his working clothes home. He had a severe attack of lead-poisoning at the end of five weeks. Another foreigner, a Russian Jew, was set to making red lead paste in a storage battery factory. He was utterly ignorant of the substances he was handling and used to moisten his fingers in his mouth as he made the paste. He became severely poisoned after ten days' work. We have found almost no effort in the lead works to instruct the foreigners in the care of their persons and in the avoidance of danger.

It is gratifying to note that the evils in the lead trades tend to grow less instead of greater because machinery is being introduced continually and displacing hand-work. As the demand for lead increases, there is more care taken against waste, which means that in well-managed establishments the fumes from smelting and refining lead are collected and the dust from grinding and sifting. All this tends to diminish the danger to the workmen. There is practically unanimous testimony from the employees in the lead trades as to this steady improvement in conditions.

Unfortunately this advance in methods of work has not been paralleled by an improvement in the care of the men. This is very imperfect in all the lead trades and in some there are apparently no measures taken to protect the men against poisoning. It is in consequence, perhaps, of this very general indifference to the welfare of the employees that we find the dangerous lead trades in bad repute with the working class, and as the employers themselves declare, only the most ignorant and helpless foreigners seek employment in white lead works or lead smelting. There are exceptions in the case of certain well-paid, skilled departments, but for the most part the lead workers are poorly paid, non-English-speaking foreigners or negroes.

These workmen are a notoriously unsteady, shifting class, and there is therefore in Illinois a large army of men who are continually moving in and out of the lead trades. A foreman in one white lead factory stated that his unskilled workmen hardly ever stayed more than a few weeks. In a large lead smelting plant in Illinois it is necessary to provide before each fortnightly pay day for new men, as 10 to 40 per cent of the men usually leave. Inasmuch as it is only with a steady force of workmen that the over-susceptible can be weeded out before they have suffered severely and the others trained to protect themselves against the dangers of the trade, it follows that this shifting of men from place to place is productive of much more poisoning than would occur among a permanent force of men. There are indications that some of the larger establishments are beginning to recognize the economic waste of this form of labor and several are planning reforms which will result in protection of the men against lead-poisoning.

Smelting and Refining.

There are three large smelting and refining plants in Illinois, one large plant which smelts and refines dross, not ore, one smaller plant doing the same sort of work, and one in which the precious metals are refined and lead is handled only as it occurs in connection with them. Two of the smelting and refining works are in the south of the state and are modern in construction and admirable in many ways. The third is in Chicago; it is old and very unhygienically constructed.

The dangers from lead smelting lie in the fumes from the molten metal, which consist in finely divided oxide of lead to which are often added arsenic and antimony, in the dust from the ore and dross and slag, and in the dust collected in the flue system. The danger from fumes is greatest in the so-called "Scotch Hearths," where the men work before the open doors of the furnaces, raking the ore and pulling out lumps of slag which are red hot and which, as they still contain much lead, give off dangerous fumes. These men are exposed to lead fumes all the time, as it is almost impossible to completely carry off the fumes from the Scotch Hearths. In the two factories in Illinois, which use these hearths, the system is far from perfect. Fortunately the Scotch Hearths are being abandoned in both places and other methods are being substituted, none of which are nearly as dangerous nor require the employment of nearly as many men as do the Scotch Hearths. The other places in which lead fumes escape are from the blast furnaces, from softening and refining furnaces, and from all the open kettles into which molten lead runs from the furnaces. The dangers from dust come from the handling of ore and dross, the breaking up of slag, the charging of the furnaces with these substances and the emptying of the flues, of the dust-house or bag-house, and the shaking and repairing of the dust-collecting bags.

In the two southern works all of the mixing of ore and dross and fume for the furnaces is carried on in separate buildings so that the men at the furnaces are not exposed to the dust. The charging is done

by machinery. In the Chicago plant the charges are prepared and the heaps of material are left standing on the floor in the rooms where all other processes are carried on, so that every man working in the plant is exposed to dust. The charging of furnaces in the Chicago plant is done chiefly by hand, and the men who do it are exposed to the fumes from the open furnaces. In the southern works there are hoods and exhausts over the vents from the furnaces where the molten lead runs out. In the Chicago works this protection has been neglected for the most part. "Skip-cars" full of molten lead are drawn through the room fuming, in all three places. The emptying of the flues is always attended with dust, but it is only in the Chicago plant that men must climb into the flues to clean them out.

The Chicago plant has no dust or bag-house. The other two have large bag-houses to which the flues run and carry the lighter fume to be deposited in long canvas bags which are stretched from the ceiling to the floor, the bottom of each bag being fastened to an opening in the floor. Each day men go in and shake the bags, and if any tear they repair them. When enough powder has fallen through the floor to the tunnel below, it is set on fire to burn out the carbon in the dust and the hot mass is then shoveled out and carried away in trucks. No attempt is made in either plant to protect the men doing this work, and it is extremely dangerous. There would be no injury to the dust if it were wet down thoroughly, but this is not done.

These two factories have stone floors or concrete floors throughout, and are kept very clean, so that there is no unnecessary dust, except in the handling of the fume. Ventilation is very good. Machinery is used wherever possible. In the Chicago plant ventilation is insufficient, the floors are old and irregular, and there is a great deal of dust due to careless handling. There is also much hand work in filling and raking furnaces. The two southern factories use an ore which has little if any arsenic or antimony, but that used in the Chicago factory is rich in both, and the fumes are easily detected by their odor.

In the factory which smelts dross but not ore, very few precautions are used. The dross of all kinds lies in heaps on the floors, making a quantity of dust. Furnaces are charged and raked by hand and there is no hood to carry off fumes. The men working at the blast furnaces are not protected sufficiently. In the smaller plant which does this same work there is far better ventilation and a higher degree of cleanliness, but there are great heaps of dross and junk of all kinds lying exposed on the floors. The provision for carrying off fumes from the furnaces is much better than in the larger plant. So little lead is handled in the one factory for refining the precious metals that there is almost no risk to the men.

None of the Illinois smelters have really adequate washing facilities for their men, and in many the provision is very poor. Nowhere are the men obliged to clean up before eating or quitting work. The smelting and refining of lead is dangerous, but the dangers can be lessened to a great exent by providing for the escape of fumes and by preventing dust.

All handling of dry metal should be done in separate rooms, and as far as possible the dust should be kept down in these rooms by continual sprinkling. The charging of furnaces should be done by machinery or under proper hood with an exhaust so that the charger is not exposed to fumes. All furnaces or receptacles in which there is melted lead should be protected by hoods with exhausts. The emptying of flues or baghouses should be done only after the fume powder has been thoroughly sprinkled so that there is no dust. This does not in any way injure the product. There should be adequate washing facilities and baths provided for the men, and they should be obliged to use them before eating lunch and before quitting work. A separate lunch room should be provided and its use made compulsory. Where large numbers of newly arrived foreigners are employed, special care should be taken to warn the men of the dangers in the work and to instruct them how to protect themselves, for which purpose it is advised that simple instructions written in various languages should be displayed about such establishments. Medical inspection should be made of all the employees at regular intervals, and no man who has once been leaded should be allowed to return to a dangerous part of the work.

It is impossible to state how much lead-poisoning occurs among the men employed in the lead smelting and refining in this state. According to physicians who practice among them, the greater number of those employed at the Scotch Hearths and in the flues and baghouses become poisoned sooner or later. The Scotch Hearth men are Americans, skilled and well paid, and they usually return to work after an attack of lead-poisoning until they are entirely incapacitated. The Greeks, Macedonians and Bulgarians are unskilled and usually leave after the first attack. The workmen say that any man becomes leaded if he stays long enough, and this statement is concurred in by some physicians.

Metallic Lead.

There are many trades in which metallic lead is handled, in some without melting; in the majority it is melted, cast, rolled or drawn out in tubes and wires. Some "junk shops" are places in which lead is simply stored, sorted and packed, though many junk shops also do some melting and casting. These places are usually ill-kept and very dusty, the facilities for washing are primitive or non-existent, but lead-poisoning does not seem to be frequent, probably because so little smelting of the lead is done. In the places where it is done the work is usually only occasional and employs few men. Sometimes it is done out of doors, which is a safe arrangement. When indoors, the kettle is usually without a hood and no effort is made to prevent dust or fumes

The largest factory making lead sheet, pipe, wire and plumbers' supplies in Illinois has fifty-eight men engaged in handling lead. It is a beautiful, clean, new factory, in which most processes are mechanical. No particular attention is paid to the men and there is poor provision for cleanliness on their part, but there is good protection against fumes, and though cases of lead poisoning have been traced to this factory, they

are certainly not numerous. All the other lead works in Chicago have been merged with this one with the exception of a small place, employing ten men only, which is both clean and well equipped.

Among the other trades in which lead is melted, cast and polished or stamped is the making of leaden coffin hardware which is done in only one factory to any important extent. The lead used contains 12 per cent of antimony, which renders it more dangerous to health than if it were pure. Aside from the usual risks attendant on work at the melting kettles, which here are not protected by hoods, there is the smoothing and polishing at wheels with or without sand, which produces a good deal of fine dust. Fifty men are employed here. The investigator interviewed one man who had contracted lead poisoning at this work and was told of two more.

In the other coffin factories the hardware is made of steel, with the addition of only a few small lead ornaments.

Another lead trade is the making of car seals, which is carried on in two factories, both employing girls. The smaller one has a perfectly protected melting pot, and the girls do not come in contact with the lead in anyway. In the larger one there is no protection against fumes and most of the twenty-seven girls employed handle lead also. The investigator was told by a former manager, by three former employes and by Dr. Pietrowicz that lead poisoning is common among the girls. One case was interviewed by the investigators.

The majority of picture frames are made of steel or wood, but two factories were found making leaden frames. The addition of antimony to the lead to harden it is found here also. In neither place is there protection from fumes and the casting is done in the general workroom, as is also the welding together of the different parts by heat. The case of lead-poisoning traced to one of these factories was a man not handling lead but working near a metal pot. About forty men are engaged in this work.

A case of lead-poisoning was traced to a factory where tinfoil is made, and two cases were reported to the commission by a physician who stated that the girls in question had contracted the poison from wrapping cigars in tinfoil. The tinfoil factory was found to be new, well-ventilated and clean, except for heaps of oxides on the floor near the melting pots. This and the presence of four unprotected kettles of melted lead, one of them giving off clouds of oxides as the workmen stirred it, furnished a plausible explanation for an occasional case of lead-poisoning. Here it would be easily possible to make the place quite safe by the simple expedient of protecting the settles and sweeping up the dust with wet sawdust.

Printing Trade.

The printing trade has undergone rapid changes of late years, leading to the substitution of mechanical processes of linotyping and stereotyping for the old method of setting type by hand. These changes have not, however, done away with the dangers in the printing trade and it

must always be remembered that there are still many small establishments in which the old hand work is carried on exclusively. The dangers in the printing trade, as in all other trades where metallic lead is handled, come from the oxide of lead which forms very quickly on the surface of molten lead and more slowly on the surface of cold solid lead. It is very light and easily carried by a draft of air.

Lead which is used in the making of type has a varying amount of antimony added to it, and according to German authorities this mixture is more detrimental to health than is either metal by itself. The pots or kettles of type metal and those used to melt the skimmings or so-called dross (oxide of lead) are usually not kept very hot—about 500° C. Lead does not volatilize under 1000° C. at the lowest, and it is often believed that there is no danger of fumes below that temperature. There are, however, abundant fumes which rise from a pot of melted lead at any temperature whenever it is stirred or skimmed or in any way disturbed, as by the common procedure of dropping cold stereotype plates or type into the kettle to be remelted. If the melted lead is left undisturbed as it is in the linotype machines, it is hard to see how fumes of lead can rise from it, and cases of lead poisoning among linotypers are said by the printers to be very rare.

Aside from the filling and skimming and stirring of the melted lead, dust is caused by the habit of emptying the ladle by knocking it sharply on the edge of the kettle, also by throwing the skimmed-off dross on to the floor, where it rises in dust; also the breaking of the dross or metal to prepare it for remelting.

Other dusty processes are the melting down of kettles full of dross, cutting off the tails from the plates, which is done at machines furnished with down suction, but which nevertheless is usually accompanied with the formation of some dust. As for the solid lead, there is very little risk, if any, in handling freshly made type or plates. It is old type covered with oxide that causes the most danger to the compositor. Polishing this old type with emery, a task usually entrusted to girls, is very bad. The blowing out of old type to get rid of the oxide dust is also bad. Fortunately there is now an increasing tendency to remelt old type instead of using it over again.

The following are the processes in printing in the order of their danger:

Work around the kettles, especially melting dross and old type; polishing old type with emery; setting old type; stereotyping; electrotyping; linotyping; the work of the stone men; compositors working with new type.

The distinctive thing about the hygiene of the printers' trade is that all of the risks to health to which the printer is exposed are avoidable, none of them are inherent in the nature of the work. This trade more than any other lead trade that has been studied, suffers from the conditions under which it is carried on. The majority of the places visited are in dark, overcrowded, uncleanly rooms, sometimes in the basement.

The kettles are almost never sufficiently protected and in many places not protected at all. Ventilation is practically never sufficient. Cleanliness was found to be the exception. If any sweeping is done it is dry sweeping. The floors are almost never scrubbed or even sprinkled. The work done in these places is often very careless. Where the kettles are protected by hoods with a draft only strong enough to carry off small amounts of fume, the workmen are in the habit of throwing in five or six plates for remelting at once and raising an amount of fume which spreads through the whole room. The skimmings of dross are often dropped on the floor. Dust is allowed to accumulate everywhere and the blowing out of the old type is often carelessly done. Provisions for cleanliness are sometimes utterly inadequate and in a neglected condition. They are seldom sufficient to insure the men eating with clean hands and not carrying lead dust home on their hair, face and clothes.

These evils are all entirely preventable and there is no reason why the printers' trade should not be healthier than almost any of the other lead trades. The impression gained by the investigators was that the conditions in the shops depend entirely upon the standards of the individual manager. Some of the best places found are small and insignificant, and some of the worst conditions are in large newspaper offices.

The authorities on lead poisoning state that in printers it usually assumes the chronic form, seldom the acute, and our experience bears this out. Only 36, possibly 40, cases of acute lead poisoning were discovered, almost all of them having occurred during 1910. A study of the death benefit records of the union shows that the causes of death are suggestive of chronic lead poisoning, with hardening of the blood vessels and changes in the heart and kidneys, for printers have an excessive death rate from apoplexy, kidney disease and heart disease.

Plumber's Trade.

Both in the making of plumbers' supplies and in the plumbers' trade far less lead is used than was the case twenty or thirty years ago, and there tends to be still less, as the substitution of iron and brass for lead becomes more and more general. In Chicago it was found that certain parts of the city still use the old-fashioned form of plumbing, but over the greater part of the city wrought iron pipes and traps are used. In the largest plumbers' supplies factory only 13 out of a total of 2800 men handle lead pipes, tanks and solder.

The men engaged in the trade assert that lead-poisoning is becoming a thing of the past, but investigation shows that there are still instances of it to be found and that even the most modern plumbing requires the use of some lead.

Analysis was made of some twenty-four samples of dust collected in places where plumbers were working on the old-fashioned lead pipes, the dust being collected from projections near the men at work. Less than 50 per cent of the samples showed lead.

In order to discover any possible cases of lead-poisoning the members of the Plumbers' Union were interviewed by the investigators and a large meeting of these men was called. One of the physicians employed by the commission addressed this meeting, explaining the symptoms of lead-poisoning and asking if any men present had suffered from it. Thirty-seven of the 300 men attending the meeting presented themselves for examination as possible cases of lead-poisoning, but only ten could be pronounced such by the physician who examined them. Of six other suspected cases, three were pronounced to be old cases of plumbism. A similar examination was made of fifty-two cable-splicers doing underground work for a large electrical company. Six mild cases were found among these men. None of the nineteen cases thus discovered represented a severe form of lead-poisoning.

It would be a simple matter to rid the plumber's trade of lead-poisoning altogether, for the only thing needed is personal cleanliness. The habit of chewing bits of lead (all but 16 out of 100 men questioned as to this admitted that it was their habit), of chewing tobacco handled with unwashed hands, and of eating lunch with unwashed hands, is probably responsible for the few cases of lead-poisoning which do occur.

White Lead.

There are four factories in Illinois which manufacture white lead. Three of them use the old Dutch process, which consists in casting metallic lead into thin plates, placing them in earthen pots with weak acetic acid and burying the pots in stacks filled with fermenting tan-bark, where the change from metallic lead to the white carbonate takes place. White lead is very poisonous, because it is easily absorbed by the human body. It enters the body chiefly through the mouth, being carried in with food or tobacco that is handled with dirty hands, or being breathed in with the air and either swallowed from the mouth or carried on to the lungs. It is not absorbed through the skin. The processes through which the white lead has to pass, from its formation in the tan-bark stack to the final product, involve a good many dangers to the workmen, depending largely upon whether machinery or hand labor is used and whether there is a high standard of cleanliness in the factory.

First, the corroded lead, which is now white lead with a small amount of uncorroded metallic lead, must be taken out from the tan-bark stack and the uncorroded part must be separated from the corroded. The white lead is then ground in water, strained and bolted, and all the time small particles of unchanged lead are being removed and carried off, either to be melted again or to be corroded again. As soon as the white lead is in water there is no danger to the workman unless the tanks leak badly and the floor is allowed to dry and get dusty. In the emptying of the stack and in handling the unchanged lead, which has a good deal of white lead sticking to it, there is always more or less dust.

The ground white lead and water are pumped into large drying pans, and when all the water has been driven out these pans must be emptied by shoveling the white lead into some receptacle, sometimes a closed hopper, more often an open truck. This process and the original emptying of the stack are everywhere recognized as the two most dangerous tasks in a white lead factory, although it is almost equally dangerous to pack the dry white lead in barrels and to head up the barrels. Some of the dry white lead is ground in oil and this is a dusty process or not, according to the care with which it is done. In some places it is quite safe. Besides the lead ground in oil and the dry white lead, some factories also make what is called "pulp lead," which is by far the safest product as far as the health of the workmen is concerned. No drying is needed for pulp lead. The water is driven out by grinding with oil.

The fourth factory uses a rapid method of corrosion known as the Carter process, in which the lead is reduced to a fine powder and sprinkled with acetic acid. This process involves a great deal of dusty work, more than any other, and is consequently the most dangerous process known. This and one of the old Dutch process factories belong to the National Lead Company; the other two are independent plants.

Of the four factories in Illinois not one can be considered safe, because the American process of manufacture involves so much handling of dry white lead. In Europe and England, dust is controlled by the liberal use of water. The floors of the factory must be smooth and hard and kept flushed all the time. The white lead in the stacks must be sprinkled before it is handled. The separation of the white lead from the unchanged lead is done under water. There are no large drying pans, no shoveling of the white lead. All trucks are covered and there are hoods with exhausts over all openings for the white lead.

The dangers peculiar to the American process are diminished to some extent in the best managed Illinois factories. One has concrete construction throughout, the other two have some concrete floors, although not in all of the rooms. These are far better than wooden floors, because they are smoother and can be kept clean. One factory is experimenting with a pneumatic cleaner to get rid of sweeping. All three which use the old Dutch process just described employ machinery to an increasing extent and thus do away with an increasing number of workmen.

The National Lead Company is devoting much attention and incurring a large expenditure of money in the effort to improve its old Dutch process factory in Illinois. This is also true of one of the independent manufacturers, who is very eager to do all he can to safeguard the men working in his factory. Both of these are model factories, according to American standards, and there is every reason to suppose that they will go on improving. The same cannot be said for the other independent plant, where the construction is admirable in many ways, but the management is not so intelligent and there is no apparent effort made to protect the men from poisoning. Even in the two factories where the managers are doing all that they believe possible to render the work safer

there still remain processes which are very dangerous, such as the emptying of the stacks and of the drying pans and the heading up of the barrels. So far no method has been devised for rendering these processes safe. Only one of the three factories has done away with hand trucking altogether, in the other two trucks are still emptied by hand. Wet sweeping or flushing is the exception, dry sweeping the rule. Very good lavatories are provided in all these places, but the men are not obliged to use them. None of the factories provide working clothes nor do they oblige the men to provide them. A man may go home in his lead filled clothes without so much as washing his hands. Lunch rooms are provided, but the men are not compelled to eat in them, although there is some effort made to persuade them to. The use of respirators is general in only one of the three, where the employer encourages the men to use pads of moist cheese-cloth instead of the bulky, heavy rubber and sponge respirator, which the men find very hard to use.

The one factory using the Carter process is the oldest of the four factories. The construction is not modern, and as the process used involves the handling of much dry lead dust, this is the most dangerous of the four factories. In consequence, the company has adopted measures for protecting the workmen which are in advance of those used in any other factory in the state, such as the compulsory use of respirators and overalls, compulsory washing and bathing, and a careful weeding out of over-susceptible men. As medical inspection is made of all workmen, early cases of lead-poisoning can be detected and given appropriate treatment.

Although the present condition of this plant is not good, the investigator has been assured that many improvements are to be slowly instituted. The National Lead Company has an experimental Carter plant in Chicago, in which new machinery is tested and when proved successful it is to be installed in the present plant. This means that the working force will be greatly diminished, dust will be lessened and therefore the amount of lead-poisoning in the factory will not be so great as at present.

In England and in Europe the men working in white lead are obliged to wash carefully before lunch and before quitting work. Those exposed to dust are obliged to bathe daily in the factory. Time is allowed for washing and bathing. Work clothes, sometimes including caps and shoes, are provided, kept clean and mended by the employers. Respirators must be worn by all men who are exposed to dust. The use of a separate lunchroom is compulsory. Half an hour is allowed for breakfast, which is especially necessary, as there is much danger of lead poisoning if a man is working on an empty stomach, and foreign workmen are accustomed to breakfasting a couple of hours after starting to work. In these countries there is also regular medical inspection, which includes the men who quit work for unknown reasons, so that no case of lead poisoning can escape the physician. A man who has once been leaded is not permitted to go back to handling white lead.

In one of the Illinois factories belonging to the National Lead Company, there has been regular medical inspection for more than a year.

In the other the same system has just been instituted. In a third, an independent plant, there is a physician employed to examine the men who complain or who are suspected of being sick. There is no inspection at all in the other independent plant. In none of the last three is an effort made to detect and dismiss over-susceptible men. In none are the men who quit work followed up. In none is there any rule against sending a man who has recovered from lead poisoning back to his old work; on the contrary, in at least two of the four this is regularly done.

The comparative results of the European system and of our system may be seen in the following figures:

In one English white lead factory employing 182 men careful medical inspection failed to discover one case of lead poisoning in the year 1909-10. In an Illinois factory employing 142 men, partial inspection revealed 25 men suffering from lead poisoning last year. In another English factory employing 90 men, no case was discovered for five successive years. In an Illinois factory employing 94 men, 28 per cent of all employees have had lead poisoning and 40 per cent of all employed in the dustier work. The other two Illinois factories have not had medical inspection and accurate figures cannot be given. One has sent four cases of lead poisoning to a hospital during the last month, the other three. These figures certainly do not represent even one-half of the probable number of cases, for many do not seek hospital care. Yet, even these would mean an average yearly of 36 and 48 cases, respectively.

In the two last cases of lead poisoning reported from the County Hospital, the men, evidently very susceptible to lead, had been put to work at once in the drying room, with the result that one was poisoned after five weeks' employment, the other after eight.

The fundamental difference between the European and the American white lead industries lies in the dustiness of the process used in America, and the fact that the men here are not compelled to take care of themselves.

The only way to make a white lead factory in Illinois a safe place to work in and the only way to prevent lead poisoning is by strict supervision of the men, care to avoid unnecessary dust, short hours of work in the most dusty processes, and a steady force of workmen from which the most susceptible have been eliminated by the medical inspector and who have been trained in the proper care of their health. Compulsory medical inspection and compulsory use of washrooms, respirators and lunchrooms are all essential.

Interviews have been granted to one of the investigators by the managers of all four white lead factories, and in three, two belonging to the National Lead Company and one of the independent plants, there has been expressed a desire to institute any suggested changes which are found practicable; for instance, the compulsory use of the lavatories and lunchroom; compulsory medical inspection with rejection of over-susceptible men; allowing time for breakfast; providing some hot food at a small price for the noon meal and hot coffee for breakfast; arranging for shifting of workmen from dangerous to safe tasks. There has been so far

no offer on the part of one of the independent plants to institute any reforms, although they have an increasing amount of lead poisoning among their employes, as shown by hospital and dispensary records.

The difficulty of protecting the workmen in our white lead factories is increased by the fact that the majority of the employees are newly arrived foreigners, many of whom are quite ignorant of the dangers they are exposed to and do not understand explanations given in English. It is desirable to have affixed to the walls of these factories simple instructions in different languages as to the necessity of personal cleanliness, of the use of a respirator, etc.

Manufacture of Dry Colors.

In the manufacture of dry colors certain salts of lead are handled, such as lead acetate, or sugar of lead, the carbonate or white lead, chrome or yellow lead, and the oxide or red lead. There are four large dry color establishments in Illinois. In two, the plants are new, well constructed and with concrete floors. The third and fourth are of older construction and have wooden floors.

The dangers to the workmen in the dry color houses are connected with the handling of the dry lead compounds, wherever this is done without precautions against dust and without insuring the cleanliness of the men when they eat and when they quit work. In one of these factories the precautions taken are decidedly greater than in the others. The whole building is of concrete and there is absolutely no dust in the greater part of the factory. There is, however, danger in the shoveling of the dry white lead from the barrels to the scales and from here to the oil mixers, although the manager endeavors to have this done with care not to raise unnecessary dust. There is an excellent lavatory in this factory, but the men must provide their towels, soap and overalls. This factory deserves unqualified praise as far as construction goes and the manager is anxious to do all he can for the safety of the workmen, yet certain precautions against dust are absent here, which would be found in the most cheaply managed English factory.

The second factory is well constructed, but the handling of the dry lead compounds is done far more carelessly and there is more dust. This factory has many cases of lead-poisoning, although the management provides overalls and towels and soap, and compels the men to use them. They also provide a lunchroom and claim that the men do not eat in the workrooms. Their failure comes from neglecting precautions against lead dust, and the results are shown in the statements obtained from physicians which give a yearly average of about 11 cases of lead-poisoning from the dry color department of this factory. Eight cases were interviewed by an investigator. In contrast to this we may point to Borrell & Company, Paint and Dry Colors, London, where 81 men are employed and where there has been no case of lead-poisoning since 1902.

Of the other two dry color establishments neither is modern in construction, nor clean, although one is far dustier than the other. In both, dusty processes are carried on without any precautions and the

men working there are covered with the dry lead pigments. Soap and hot water are provided, but no towels, overalls or gloves, and the men are allowed to eat where they please. There is lead-poisoning in both of these factories.

Paint Houses.

Aside from the four dry color houses already described, there are eight paint factories in Chicago. There is not as much danger to the health of the men employed here as in the dry color works, the only risk being in handling the lead salts before they are ground. Such places can easily be made safe if the floors are smooth, if they are kept clean and kept wet, if care is used to have hoods and exhausts over the machines in which the lead salts are ground. The eight places visited in Chicago are none of them ideal, although two of them are very clean. In the others the danger to the workman depends upon the amount of white lead which is used in the establishment, for some use very little, and employ instead comparatively harmless substances, such as zinc or the sulphate of lead or barytes, so that even if there is carelessness and dirt the men are not exposed to lead-poisoning. In three, washing facilities are insufficient and inaccessible and the workmen eat in their workrooms. The dusty processes are not separated from the not dusty work, as should be done. For instance, a girl engaged in labeling paint cans in one of these paint houses contracted lead poisoning because she was stationed near enough to the scales where the white lead was weighed to inhale the dust raised in this process. Fortunately for the workmen, there is a gradually increasing tendency to substitute harmless or almost harmless pigments for white and red lead. Graphite and the German reds are largely replacing red lead. Zinc, sulphate of lead and barytes are to a certain extent displacing white lead.

The Painting Trade.

The painting trade is numerically the most important of the lead trades; 27 per cent of all the individual cases on our list are painters. This is not because the trade is more dangerous than the other lead trades. It is simply because many more are employed in it than in any other one lead trade. The lead poisoning of painters is apt to be slower in onset than in many other trades. The painters themselves state that it is very rare for a case of lead-poisoning to develop during the years of apprenticeship. Sometimes it does not come on till late in life, after pneumonia or some other disease has weakened the body. Being a skilled trade, men are loath to give it up, even after they know that they are leaded, and they often return to it again and again until finally they are incapacitated by paralysis. The dangers in the painter's trade come first from the paint being carried into the mouth by the fingers; second, from the dust which is formed during the mixing of dry white lead or red lead, and during the dry rubbing down of white lead paint. The first danger is very generally recognized by painters and can be easily guarded against by careful washing

of the hands before meals when this is possible, but in the large majority of cases there are no washing facilities for men engaged in house and sign painting. The second cause of lead poisoning, namely, dust, is far more important and is often quite beyond the control of the painter. Mixing of paints is not generally done. It is more often entrusted to one or two men, who mix for the others. On the other hand, white lead putty, when this is used, is handled by many men who also sometimes add dry white lead to it to stiffen it. The most dangerous part of the painter's work consists in rubbing with sandpaper the coats of white lead paint after they are dried so as to roughen the surface and prepare it to receive another coat. This sandpapering produces clouds of very fine white lead dust, which the workmen breathe in. It is done usually inside a building, in interior work in houses, in the painting of railway cars, street cars, carriages, coaches, automobiles and even wagons. The room in which the work is done is tightly closed to keep out drafts of air which might scatter dust on freshly painted surfaces. There is never any exhaust system to carry off the dust which falls on the floor and is stirred up by the feet of the men. The paint which is sanded often contains as much as 80 per cent white lead, the putty, which is also sanded, may be 95 per cent white lead.

Very rapid cases of lead poisoning and very severe forms develop as a result of this work of sandpapering lead paint. In one establishment where railway coaches are manufactured, three cases developed recently in men none of whom had worked more than four weeks. One was a newly-arrived Italian, who had been engaged in sandpapering all day. He was not a painter by trade, had no idea of any danger connected with the work. What made his part of the work especially bad was that he was rubbing the painted ceilings of railway coaches and in the small enclosure there was no escape for the dust.

Another danger the painters encounter is the rubbing down of old lead paint in making repairs. Where the paint is burned off there is far less danger, but even here the old paint falls to the ground, dries and gives rise to dust.

The statement is usually made that it is impossible to protect the painter from lead poisoning unless the use of white lead in paint is altogether abolished, as it is soon to be in France. German, English and Belgian authorities dissent from this, but they believe that the use of white lead should be restricted to exterior work and zinc white be used for the interior. This is said by many to be superior to white lead for interior use.

In Belgium the law forbids dry rubbing of any lead paint. In England, wet rubbing seems to be universal, even on the finest coaches and automobiles. In Germany, the building contractor is obliged to provide a warm, abundantly equipped lavatory in which the painters he employs may wash and eat their lunch. This must be done even when the buildings painted are outside of cities.

In order to protect the American painter, the first thing needed is that he should be instructed as to how to take care of himself. He should be taught that the danger comes from lead smeared food and

tobacco, not from absorption through the skin. If he is obliged to work at dry sandpapering he should be protected by a system of suction fans to draw the dust away from him. The floor of buildings in which such work is done should be smooth and hard and kept wet. The men should be furnished respirators, caps and overalls, should work for short hours and be frequently shifted to less dangerous work.

The investigation made of this trade is very far from complete, for there are in Illinois about 20,000 painters in the Painters' and Decorators' Union, and supposedly half as many outside the Union. The officers of the Union rendered much valuable help to the Commission and through their records of sick benefits it has been possible to discover cases of lead poisoning and to have medical examination of many of those in which lead poisoning seemed to be indicated, but this last could be done only in Chicago and is not yet completely done even here. The work among non-union painters was attended with far more difficulty, of course, and the number of cases discovered does not represent anything but a fraction of the real number. There is in all probability much more lead poisoning among the non-union painters than among the union men, for they are employed largely in indoor work the year round, painting railway and street railway cars, carriages and automobiles, wagons and agricultural implements. Such work usually involves the sandpapering of lead painted surfaces in closed rooms, which is known to be the worse part of the painters' trade.

It has not been possible, for lack of time, to search for cases of lead poisoning among the non-union painters, except as these were found in hospital and dispensary records or were reported by physicians, and the investigators feel that many would be discovered if the men employed in certain establishments could be examined. For instance, there are carriage shops which are unable to keep anything like a steady force of workmen and where the conditions are so bad as to suggest that the men leave on account of ill health. One such place has a payroll of only 13 men, but takes on 50 in the course of the year. Another is obliged to employ 300 men a year in order to keep up an average of 50. In some of the shops where railway cars are painted or repaired, there is every opportunity for rapid absorption of lead by the many men who work in the same room. It is a very important branch of the lead trades and one which merits much more study.

Mechanical Artists or Retouchers.

This is a highly skilled trade, said to employ about 520 persons in Chicago, both men and women. It is well paid, carried on under pleasant surroundings and attracts educated and talented young people, many of them earning enough to enable them to go on with their training at the Art Institute. The work consists in making paintings in color, or more often in black and white, for catalogues, advertisements, picture cards, etc., also in retouching with white paint photographs for catalogues and pattern books so that these will reproduce better. The engraving houses and large manufactures in which this is done usually provide large, light, clean rooms for their artists, the ventilation in which is not always good, because the sedentary employment makes the artists dread cold air. These artists are paid good

wages, their hours are usually not more than eight or eight and one-half a day, but in spite of all these apparent advantages the profession is notoriously unhealthful. The men say that they all have stomach trouble, that they are obliged to take vacations from time to time, that many cannot stand more than a few years of it, that they do not understand where the danger lies. They use white paint, putting it on with a fine brush which they habitually suck to bring it to a fine point. Besides this, they use an "air brush" which by means of compressed air sends an exceedingly fine spray of white paint over the picture. The paint used is very powdery when it dries and if too much has been put on, the excess is blown off by the "air brush."

Most of the artists believe that this white paint is zinc white and state that their employers and foremen have told them so. The investigators were also told that all the white paint used in certain establishments was zinc white. Two physicians reported to the Commission puzzling cases of apparent lead poisoning in men using zinc paints. Other cases came to the knowledge of the Commission where physicians had been completely misled by the statements of their patients and had consequently treated them for diseases which they did not have. On questioning the men closely, some say that they believe it is dangerous to put the brush in the mouth, others believe that the chief harm comes from breathing the spray from the air brush. One man who was careful not to put his brush in his mouth said that he noticed that his nostrils were white after a day's use of the air brush.

The Commission had analyses made of eleven of the whites used in these establishments and found that seven consisted of white lead paint. Only four establishments were found in which at least one variety of white lead paint was not used. This is a trade in which protection of the workmen would be comparatively easy, for what is chiefly needed is that they should be instructed as to the nature of the paint they are using and the dangers connected with it. They should be warned against putting the brushes in their mouths and should be told of the danger of eating without first washing the hands and rinsing the mouth. Some simple form of respirator, preferably a muslin bag, should be advised during the time that the air brush is used. It is, of course, most desirable that the rooms should be kept clean, that there should be no dry sweeping, and that the ventilation should be good.

Lead Oxide Works.

There is only one factory in Illinois which manufactures the lead oxides known as red lead and litharge. This is a modern factory, very well constructed with concrete floors, and it is kept scrupulously clean. The use of machinery is carried to a very high point. The dangerous parts of this process are the handling of the refuse from white lead factories, which is dried and full of white lead powder, the conveying of red lead in open trucks to the grinder, and shoveling into the furnace the dried refuse from this grinder. The drying room is also unsafe because the dry red lead must be shoveled into trucks and then into grinders. Another dusty process is the packing of the dry red lead into barrels. All these processes are recognized as dangerous in this

Illinois factory and every effort is made to replace hand work by machinery and to provide a perfect dust-collecting system. The factory compares well with the best of those in England and Europe.

Litho-Transfer Works.

This work is done in lithographic establishments, only two of which in Illinois have a litho-transfer department. The work consists in making transfers which are used in impressing patterns on pottery. The colors for this work are ground dry and are then dusted on to prepared paper. It is the only dry color work that is carried on in a lithographic factory; the rest is all wet. The danger in color grinding is that the dust of the lead colors escapes and may be breathed in and the fingers of the workman become covered with this dust. In the transfer work girls are usually employed, this being one of the few lead trades in which many girls are found. It is a decided disadvantage, from the point of view of industrial hygiene, for girls are everywhere recognized as more susceptible to lead poisoning than men. Girls in litho-transfer work usually do the color dusting at a table provided with a glass screen and canvas flaps through which their hands pass. The protection afforded is very incomplete, because the canvas is usually torn, also the girls sometimes remove the plates of glass in order to see better. These tables with the hand work are being displaced by large machines from which there is very little escape of dust and which necessitate little hand work. The girls employed at these machines, however, wear cloths to protect their hair from the dust and these cloths, as well as their gloves, are stained with colors, showing that the machines have not abolished the lead dust. In one litho-transfer factory there is also a room in which aluminum foil is applied to prepared paper by hand. The girls in this room are covered with light fragments of foil which sticks also to their hands. This foil contains 7 per cent lead.

Litho-transfer rooms should be kept very well ventilated and as dust free as possible. The floors should be often swept with wet sawdust. Special care should be taken that the girls wash before eating and eat in a separate room. It is far better not to employ girls in such a place. In the large litho-transfer factory in Chicago eight girls and one man have come under the care of a physician for lead poisoning during the last two years. The man was employed in color grinding, the girls in dusting the color on paper.

Storage Batteries.

In the making of storage batteries a metal plate or grid with holes or ridges is cast and the inequalities of the surface of this grid are filled with a paste consisting chiefly of oxides of lead. There are four parts of a storage battery factory in which the workmen are exposed to danger. First, the casting room with the vessel of molten lead; second, the room in which the oxides are weighed and mixed; third, the paste room, and fourth, the room in which the plates are dried. In Europe this is recognized as a dangerous trade and it is hedged around with many safeguards for the prevention of lead poisoning.

In Illinois there are no large storage battery works, but many small ones, some employing only three or four men. In consequence the

equipment is usually very inadequate and the protection of the men is not at all sufficient. The melting pot usually is not hooded and though there is little escape of fumes as long as the lead is not stirred, there is always some danger when the lead is ladled out for casting. The dross on the surface is often skimmed off and thrown on the floor, so that the room is very dusty. Frequently all of the processes are carried on in the same room. The oxides are mixed usually with precautions against dust, but the powder is given to each man to make into paste and this causes a great deal of dust. In one place the pasters do their work under glass screens with canvas curtains, through which the men's arms pass, but in most places they work at unprotected tables. Their clothes, caps, shoes, faces, hands and hair are red with dust. The drying room is usually small and the men are not obliged to enter it, but can remove the plates by opening the door. These dry plates can be handled without much risk, but in some places they are scraped in order to get rid of the excess of paste, which should have been removed while they were still moist, and this causes a dangerous amount of dust.

In places where worn-out plates are collected and recharged or melted there is an additional source of dust, for these old plates give off a fine powder of oxide of lead as soon as they are touched.

The washing facilities are very rarely adequate. A lunch room is not provided in any of the establishments visited. Working clothes are not provided, although it is true that most men are obliged to wear special working clothes, because the red lead dust is so abundant that their clothes and shoes could not be worn on the street.

The storage battery works in Illinois give rise to a great deal of lead poisoning. The men acknowledge that they are usually ignorant of the nature of the substances they handle, nor do they know the dangers of the work. Some of the most rapidly developing and severest cases of lead poisoning we have discovered have come from storage battery plants. Yet it is possible to render such places quite safe and healthful, as is shown by the records of large factories in England.

At the Hart Accumulator Works in London 80-100 men are employed and there has been no case of lead poisoning for over a year. On the other hand, one small plant in Chicago, belonging to one of the railroads, employs only 15 men, but had two known cases of lead poisoning in a period of nine months.

To render safe a storage battery factory the following measures should be adopted:

The casting should be done in a separate room, clean, and with a hooded kettle. The measuring, mixing and grinding of the oxides and the making of the paste should be done by one man in a separate room, well ventilated, the floors of which should be kept wet. The pasters should work at a table with a hard, smooth surface so that it can be washed clean. They should not be allowed to handle the powder, but should be given the paste already made. There should be no scraping of plates after they have left the drying room. The floors of the factory should be hard and smooth and kept wet. There should be adequate washing facilities and the men should be obliged to use them.

The men should be obliged to change their clothes before leaving the factory. A lunch room should be provided and its use made compulsory. The men should be warned of the dangers of breathing or swallowing the red lead dust. If old battery plates are reassembled or remelted, they should always be sprinkled with water before they are handled.

Putty Powder.

There are two methods of finishing cut-glass, either by some strong acid, sulphuric or hydrofluoric, or by a powder composed of three parts oxide of lead to one part oxide of tin. The latter process is being abandoned gradually but is still in use in one of the eight cut-glass establishments visited. This powder, made into a paste, is applied to the glass and the glass is then held against the polishing wheel, which causes the thin paste to spatter in all directions over the person of the workman, over his neighbors and over the walls and floor. As it dries it forms a light dust, which spreads through the room. The articles covered with this powder are washed and dried, usually by girls, who may work in the same room with the polishers. In that way all the employees may become exposed to the lead dust.

Polishing cut-glass is listed as a dangerous trade by the Prudential Life Insurance Co., and the people engaged in it are rejected. In one such establishment in Chicago where only two men are engaged in the actual polishing, two cases of lead poisoning were reported by a physician last spring.

Such factories should furnish overalls and caps for the polishers. Their work should be done in a separate room, the floor of which should be kept wet. Everyone using the powder or handling glass covered with it, should be given time and facilities for thorough washing of hands and face before eating or quitting work. It is essential that the workmen understand what it is they are using, and for this purpose simple statements explaining the necessary facts should be displayed in these establishments.

Glazes and Enamels.

Red lead is often used in the making of glazes and enamels for pottery, enameled signs, sanitary ware, tiles and glazed bricks. There are two ways of using red lead in the making of enamel, one of which is safer than the other. By the first method the lead salt is mixed with the glaze-forming constituents, is then melted and after it is completely fused, reduced to a powder. This changes the lead from a soluble, poisonous form, to a much less soluble and safer compound. By the other method the original mixture is applied directly to the object to be glazed without any previous fusion. The glaze in either case may be applied wet by dipping or brushing or spraying, or it may be scattered on dry. The last is, of course, attended with much more risk than the wet process. In a few instances white lead is used instead of the red lead.

In investigating the glazes and enamels made in Illinois, it is found that several do not contain lead oxide, zinc being substituted for the glazing of pottery, tiles and bricks, in four of the nine establishments concern-

ing which we have information. Kitchen utensils seem to be invariably finished with a glaze free from lead. The two largest establishments in the state making kitchen ware were visited and information was obtained concerning the smaller factories also. No lead is used in any of them. The investigators also were informed that no lead is used in the one large establishment making enameled signs.

Of the five potteries using either red or white lead, only two were visited. In the one which uses white lead the dry salt is not handled with much caution, though only four men are exposed to it. After it is mixed with water the workmen dip this wet lead mixture from the tub and pour it over the tiles, which they hold in their hands. The tiling should be held in such a way that the lead glaze does not reach the workman's hands, yet their hands are soon covered with it.

The foreman stated that it was impossible to make the men wash properly, but that they were foreigners and came and went all the time, so that nobody knew if any of them fell sick or not. No towels are provided. About 1,200 pounds of white lead a day are used and 140 men employed. The other pottery visited uses red lead mixed with water and employs only two men.

There is one large establishment in Illinois which makes sanitary supplies and in which about 200 men are employed in handling the lead enamel. The enamel is melted and ground before being applied, so that the lead is changed to an almost insoluble form. As several cases of lead poisoning have been traced to this factory, careful examination was made to determine where the dangers lay and the investigator concluded that these dangers were largely avoidable, being due to careless handling of the ground enamel. There is such an excessive production of dust that some of the men become poisoned even though this form of lead is comparatively harmless. The ground enamel is left lying in heaps on the floor and is tracked over the premises by the workmen's boots. It is applied dry to the heated basin or tub by a sprinkling apparatus and while doing this work the men are in a cloud of dust. There is no system of dust collection, nor are the men protected by respirators. It would be easy to render such a place free from the dangers of lead poisoning simply by removing the dust.

Rubber Industry. Glass. Tin Utensils, Etc.

There are certain industries which are regarded as dangerous trades in many states and in Europe and England, but which are found in Illinois to be comparatively free from the dangers of industrial poisoning. The rubber industry in Illinois does not use bi-sulphide of carbon nor white lead, as is customary elsewhere. It uses a small amount of red lead, but has substituted for white lead the comparatively harmless sulphate. No cases of lead poisoning have been traced to the rubber industry in Illinois.

The glass industry of Illinois does not use lead. The making of cheap tin kitchen utensils is a dangerous lead trade in England, but in Illinois, so far as the Commission's investigators have been able to discover, cheap tin utensils are made of steel or iron covered with an exceedingly thin coat which has no lead mixed with it.

Occupation	Total Number of Cases	Sex		No. of Cases for years			Time Lost	Wages Lost	Permanent Disability	Temporary or Partial Paralysis	* Death	Compensation from Employer	Remarks
		Male	Female	1908	1909	1910							
Painters (including house-painters, wagon, car, automobile and sign-painters).....	157 and +2 suspected cases	157 (+2)	none	29	39	89 (+2)	43 years, 4 months	$46,092.0	9 +2 doubtful +2 suspected	3	9 +2 doubtful +2 suspected	None received any compensation from employer- according to reporte of investigators.	"Time Lost" has been reported by 77 workmen; "Wage Lost" has been reported by 72 workmen. The ages at which painters contracted lead poisoning vary from the age of 18 years to the age of 71 years. Some of these painters have practiced their trade for a few weeks only; others for several months, while some remained at it for as many as 40 years previous to sickness.
Printers (including type-casters, stereotypers, linotypers, electrotypers, compositors, finishers, etc.).....	36 +4 suspected cases	32 (+4)	4	3	2	31 (+4)	16 years, 7 months	$15,716.00	2	1	.....	None	"Time Lost" has been reported by 8 workmen; "Wage Lost" reported by 8 workers. The ages at which sickness was contracted vary from the age of 17 years to the age of 58 years. The length of time workers have remained at this trade previous to sickness varies from 2 months to 35 years.
White Lead Workers.....	79	79	..	9	7	63	1 year 10 months	$1,210.00	?	1	3	None received any Compensation.	"Time Lost" has been reported by 8 workmen; "Wages Lost", by 7 workmen. Age at which sickness was contracted varies from 21 years of age to 50 years. Period of work previous to sickness varies from 1 week to 2½ yrs.
Smelters and Metal Shops.....	181	180	1	55	54	72	10 months	$285.00	....	3 (temporary paralysis)	....	One employe was paid full wages.	"Time Lost" has been reported by 5 workers; "Wages Lost," by 4 workers. Ages at which sickness was contracted vary from age of 27 years to age of 60 years. Period of work previous to sickness varies from 3 months to 30 yrs.

Paint Factory Workers.....	17	16	1	3	2	12	6 months. 1 week	$314.00	....	....	1	1 workman was paid part of his wages; 1 workman was paid medical expenses.	"Time Lost" reported by 6 workmen only; "Wages Lost," reported by 6 workmen only. Age at which sickness was contracted varied from 20 years of age to 47 years. Period of work before sickness was contracted varied from 2 weeks to 5 years.
Artists (mechanical retouchers).	15	14	1	10	4	1	7 months	$12.00	....	One (?)	2	None	"Time Lost" reported by 4 men only; "Wages Lost" reported by 1 man only. Period of work before sickness was contracted varied from 2 years to 28 years.
Plumbers.....	19	19	..	2	1	16	Not reported	....	....	....	....	...	The number of cases among plumbers is small and the information incomplete because very little time has been devoted to them
Miscellaneous (comprising common laborers, storage battery workers, workers in brass, machinists tinsmiths, foundry workers, electricians, tile factories, lead factories, paper-hanger, cut glass workers, lather and shingler, litho-transfer works, pottery wks., cigar factories, artificial flowers, enamelers, copper platers, nickel buffers, cable workers and lead puttiers)..	74	63	11	14	25	35	15 months	$310.00	1 (Lead Insanity)	....	3	None of those who reported have received any compensation.	"Time Lost" reported by 8 workers; "Wages Lost" reported by 4 workers. Age at which sickness was contracted varied from 15 years of age to 65 years of age. Period of time at work previous to sickness varied from 1 month to 20 years.
Grand Totals.....	578 +6 suspected	560 (+6)	18	125	134	308 (+6)	65 years	$63,940.00	12 +(2) doubtful +(2) suspected	8 +(1) doubtful	18 +(2) doubtful +(2) suspected	1 workman received full wages; 1 received part wages; 1 received medical expenses.	"Time Lost" was reported by 116 men out of the 632. "Wages Lost" was reported by 102 out of the 632.

Note: Very few deaths from lead-poisoning have been found because the physician usually makes out the death certificate for some one of the consequences of lead-poisoning such as nephritis, gastroenteritis, etc., instead of lead poisoning itself.

Business	Firms Visited	CONDITION OF SHOP				
		Good	Fair	Doubtful	Unsatistory	Bad
Artists, Mechanical Retouchers	74	22	35	10	7	..
Wagon, Carriage, Car and Auto Painting Shops	42	9	15	1	7	..
Platers	2	1	1	..	..	..
Litho-Transfer Works	2	..	..	..	2	..
Coffin Makers	2	..	1	..	1	..
Picture Frames	16	1	12	2	3 1	.. ..
Storage Batteries	11	1	6	1	3	..
Implement Painters	4	..	3	1	..	..
Metal Shops	26	3	8	2	4	6
Zinc Smelters	2	..	..	..	..	..
Printers	83	17	33	8	18	7
Paint Factories	10	2	2	..	5	1
Smelters	6	1	1	2	2	..
White Lead Works	4	3			1	..
Wall Paper Mills	4	1	2	1	..	..
Pottery Works	2	1	1	..	..	..
Cut and Art Glass Works	8	3	4	..	1	..
Miscellaneous	5	1	4	..	..	..
Total:	304	63	128	28	54	14

Definitions.

Under "Conditions of Shop," the terms "good," "fair," "unsatisfactory," "bad," signify the following conditions.

By "good" is meant proper and sufficient ventilation, plenty of light, both natural and artificial, general cleanliness of place, provisions of sanitary conveniences, and plenty of room or air space according to number of employees.

"Fair" signifies the same sanitary conditions, which are, however, somewhat less cared for. For instance, a shop may be clean and well-ventilated, but also dim or dark; or there may be a lavatory in the shop without any soap or towels, etc.

"Unsatisfactory" means neglected or lacking sanitary provisions, as poor ventilation, dusty and unswept rooms, crowded conditions, etc.

"Bad" signifies the reverse of "good." A shop wholly neglected with respect to most or all of the desirable sanitary provisions is said to be "bad."

Arsenic.

Arsenic is used in Illinois in industry to a small extent only. White arsenic is used in solution, 1 pound of white arsenic to 1 gallon of water, by taxidermists to keep fur or feathers from being attacked by moths. The making of the solution is done usually in the open air. The skins and feathers are never handled after the arsenic has dried, and apparently there is no ulceration caused by putting the hands in this solution.

Arsenite of copper, or Paris Green, is manufactured in two establishments and handled in a third. It is a very light and fluffy powder, extremely hard to control. If it settles on the skin and becomes moistened by the perspiration, ulcers are apt to result. If it is breathed into the mucous membrane of the mouth and nose, still severer ulceration takes place. Cases have occurred of ulceration of the feet when the boots have become soaked with water holding Paris Green. The internal effects of Paris Green poisoning are shown in intestinal and nervous disturbances.

The largest Paris Green factory in Illinois employs 16-17 men. The salt is precipitated in large tanks in a room where there is no dust, but the fumes from the tanks are said to make the men drowsy. The green is run out in to filter presses, and is then carried to a hot room, where it is dried, and then carried on trays to the bolting machine, then to the filling room, where it is filled into small kegs. All of the rooms in both Paris Green factories are a vivid green color, but in the striking rooms the floors are kept wet by constant flushing. In the rooms where the dry powder is handled, there is very little effort to keep down the dust; on the contrary, it is handled with great carelessness, and consequently the air is full of it. In the larger factory, the filling of little kegs is done under glass, with canvas flaps, and there is a strong exhaust. In the smaller factory, there is no such protection. In

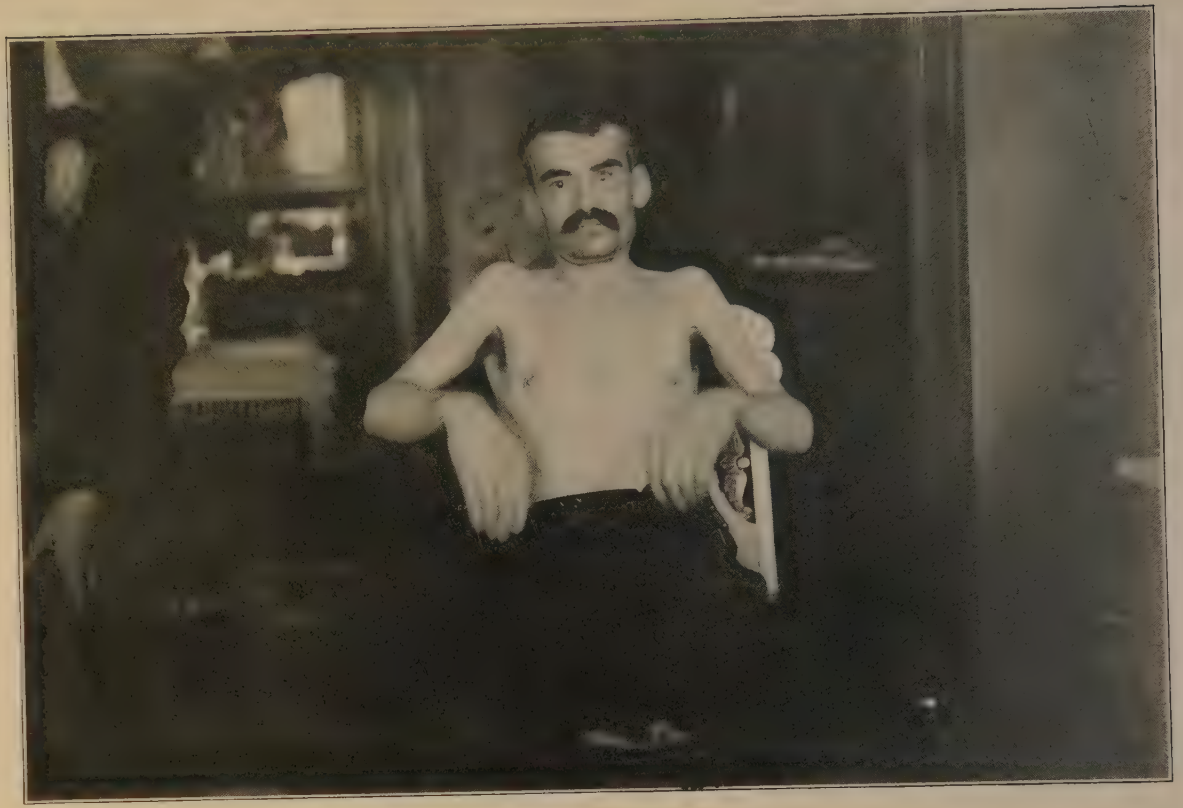
the larger, the men are furnished overalls, gloves and boots, and the overalls are washed for them. They are also made to wash and bathe regularly. In the smaller, the overalls are not furnished and the men are not compelled to use the washing facilities, but they are given boots and gloves. There is no medical inspection of either plant, but the foremen supply the men with some ointment for the face and nostrils to prevent ulceration. The larger one, which employs 16-17 men, has many cases of arsenical poisoning, and the men are continually shifting. In the smaller, 3 men work during the rush season. They usually get poisoned by the end of the season, when some quit, others take a vacation, recover and come back again. In the third factory, Paris Green is packed and shipped. The kegs in which it arrives are somewhat leaky, and there is a good deal of dust when these are opened, and the Paris Green repacked into smaller kegs. No precautions are taken here to prevent dust or to protect the men. The repacking is done by simply scooping out this arsenic green and dropping it into kegs. The employees are all negroes and frequently suffer from arsenical poisoning. Only 7 at the most are employed here, but one physician has had four severe cases of arsenical poisoning from this plant during this last year.

Because of the lightness of Paris Green it is hard to handle in such a way as not to dislodge it and give rise to dust, but this can be controlled far better than it is in the Illinois factories. The powder should not be carried on open or on leaking trays. Great care should be used in emptying the trays and in filling kegs, which last should be done under glass. All floors should be kept wet. The men's skin should be protected by good rubber boots, gloves, caps and overalls, and by the use of ointment on the face and cotton in the nostrils. The men should be warned not to breathe through the mouth. Bathing, as well as washing, should be compulsory and all necessary appliances supplied. Simple instructions in different languages should be displayed about the rooms.

There was said to be some arsenic used in a litho-transfer factory, in a place manufacturing artificial flowers, and in wall-paper factories, but the investigators were unable to verify these statements. Arsenic is not used by furriers in this state.

CASE OF CHRONIC LEAD POISONING

With double wrist-drop and extreme emaciation This man is slowly recovering at the Cook County Hospital from an almost fatal illness involving intestines, heart, and kidneys, caused by lead-poisoning. He has been a house-painter for 35 years.



CASE OF CHRONIC LEAD-POISONING

With double wrist-drop and emaciation. This man was a painter for 25 years in Germany; never suffered from lead-poisoning; weighed 205 lbs. when he came to America. After 1½ years' work here, part of the time sand-papering lead paint, he was severely poisoned. Weighs now 155 lbs.

CASE OF ACUTE LEAD-POISONING

This photograph was taken while the man was in the Cook County Hospital. He is a Bulgarian immigrant who entered a white lead factory when he had been in this country less than a week and had a severe case of poisoning at the end of 5½ weeks.

CASE OF CHRONIC LEAD-POISONING

With double wrist-drop in a man of 53 years who was a printer—a metal mixer—for 32 years.

CASE OF CHRONIC LEAD-POISONING

With wrist-drop and premature senility. This man is only 52 years old and has been totally disabled for the last 6 years. He was a painter for 20 years.

CASE OF CHRONIC LEAD-POISONING

With paralysis and premature senility. This man is only 40 years old. He has been a house painter ever since boyhood; has been incapacitated since 1905 with partial paralysis of the hands, arms and legs.

2. Report of the Investigation of the Brass Manufacturing Industry, Chicago (Cook County), and the Zinc Smelters of La Salle County, Illinois.

BY

EMERY R. HAYHURST, A. M., M. D.

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Summary of the Dangers of the Brass Industry, Hygienically Considered, with Recommendations as to its Control.

PART I.

A. MANUFACTURE OF BRASS.

(*a*) *The Alloys.* Brass is an alloy composed of copper and zinc. Fine brass or red brass contains two parts of copper and one part of zinc. However, as these two metals combine in practically all proportions many alloys are possible. As zinc is by far the cheaper of the two component metals its percentage in the alloy is likely to be much increased until a so-called yellow brass is produced in which the zinc component may be from 40 to 50 per cent. This the workmen style "cheap yellow brass."

Bronze is an alloy consisting of copper and tin. Usually the copper component is about nine parts to one part tin. In the industry, however, red brass is very often styled bronze, although zinc is the other component instead of tin. It is only rarely that these two or three metals are used exclusively in the particular alloy to be made, but, for the purpose of conveying certain physical properties to the casting, certain other metals are added, such as lead, aluminum, phosphorus, nickel and antimony. There are some three-score of these various compositions which are well known and are made up for certain purposes. For instance there is button brass, gilding brass, soldering brass, wire brass, French gold (nine parts copper and ten parts zinc), pinchbeck, aluminum brass, gun metal, statuary bronze, bell metal, phosphor bronze, aluminum bronze (nine parts copper, one part aluminum), German silver (six parts copper, two parts zinc, two parts nickel), pewter, Britannia metal, babbitt (consisting of copper, tin and antimony), and type metal.

In the usual foundry practice these various alloys are not made by putting in certain proportions of the various metals but as a rule a large percentage, from one-third to one-half on the average, of scrap brass, copper and bronze consisting of all sorts and compositions of metal gathered up usually by junk dealers, is melted down and then a little of the proper copper, zinc or nickel ingot added to arrive at an approximate composition. In fact a large amount of the so-called virgin copper, zinc and so forth used is bought from refiners of scrap metal and the composition is very uncertain. Certain foundries make a specialty of yellow brass castings, others of red brass or bronze castings, others of German silver, etc., while the refiners are concerned with the handling of all of these metals and usually with a large amount of lead.

Consequently, the brass-manufacturing industry or more properly the non-ferruginous metal-working trade is engaged in the handling of large amounts of copper, zinc and tin, while it must not be overlooked that lead, antimony, nickel, phosphorus, arsenic and cyanide compounds sometimes enter into these industries, as well as the handling of concentrated and fuming acids (muriatic, sulphuric, nitric and hydrofluoric).

Finally scrap metal, old boiler tubes, etc., by the action of air and moisture may be covered with more or less poisonous oxides and carbonates by which ignorant workmen may be poisoned both through handling and breathing the metallic dusts. In addition to the metals named above as entering into the composition of various brass alloys, the salts with which they are combined to a limited extent require some notice, such as the oxides, the sulphides, the sulphates, silicates and nitrates.

(*b*) *The Brass Foundry.* In "Modern Foundry Practice," Sharp, 1900, page 632, the author states that a Brass Foundry of moderate size and properly designed should consist of the following separate shops or rooms:

(1) Offices.
(2) Warehouse.
(3) Pattern Shop and Store Room.

(4) Moulding Shop (meaning where the moulders work impressing the patterns in sand and loam—an entirely cold process. Core making is also usually done in this room, although in large concerns there is usually a separate Core-room).

(5) Casting Shop (meaning the room where the metals are melted, alloyed and poured into the moulds). Nos. (4) and (5) are often together but should be separate.

(6) Dressing Room (where the rough castings are preliminarily cleaned up, the various processes being "blowing the cores," in which the casting, still hot, is let down into a tank of water and the sudden change in temperature causes a mild explosion which dislodges and destroys the cores within the casting; tempering and hardening; tumbling or washing in a revolving barrel of water to free the dirt that may remain; grinding on emery wheels to remove the rougher and larger metallic knobs remaining after knocking off the "gates").

(7) Finishing Shop (polishing, buffing and machine work of all descriptions. The last process and the polishing and buffing should be in entirely separate rooms).

[(8) Dipping and Coloring Room.

(9) Lacquering Room.

(10) Plating Room.]

(*c*) *The Furnaces.* Brass furnaces may be earthen or graphite crucibles heated within iron cylinders, reverberatory furnaces, or cupolas, the latter the best. Fuel may be charcoal, coal, coke, gas or oil.

Catalogues of Furnace Manufactures show the following types which may be used for brass, bronze, aluminum, iron, steel, copper, etc.:

I. Crucible Furnaces—
   1. Pit type (below floor, top on level with floor).
   2. Lift out type (all above the floor).
   3. Tilting type, upright (tip-over-and-pour).
   4. Tilting type, horizontal (tip-over-and-pour).
   5. Mint type (for fine bars and anodes).

II. Muffle furnaces (especially for silver).

III. Reverberatory scrap melting (for all metals).

IV. Soft metal melting (for lead, tin, zinc, babbitt, etc.; for alloying, tinning, galvanizing, tempering, etc.).

V. Add to the above retort furnaces and the list is complete.

What is of hygienic importance is that such furnaces are illustrated in these catalogues with broad overhanging hoods or canopies covering the tops of furnaces or furnace area, and tapering above to a pipe leading to chimney or stack for collecting the furnace gases and vapors and allowing them to escape.

(*d*) *Brief Description of the Process of Brass Founding.* This may be quoted from Thurston's "Alloys, Brasses and Bronzes," pp. 205-214.

On p. 207 he states: "The flasks (moulds) and all details of apparatus, tools, and work are very similar to those used in the iron foundry, and the methods are the same in the main." * * * "In the melting of the materials in the making of alloys in the foundry two general methods of procedure are practiced: in the one all the constituents are fused at the same time in the same crucible or melting pot; in the other they are fused one after another in a definite order, which is determined by the relative fusibility, volatility, and liability to oxidation, or to absorb oxygen or other gases. The first of these methods is, perhaps, the most common, but the second is by far the best; thus in making the most common ternary alloys (those of copper, tin, and zinc) the copper is best melted first, the tin should be next introduced, and the zinc, which is volatile and oxidizable, is added last. If lead is to be used in such an alloy, it is found best to put it into the crucible last." Page 209, "In filling the furnaces, the crucibles are slowly heated to avoid danger of breaking; they are at first set bottom side upward. When well heated they are set mouth upward and charged with the broken copper. The tin or zinc is heated at the mouth of the furnace and is added gradually to the copper as the latter becomes fluid. The zinc is liable to volatilization and is, therefore, when introduced, plunged well below the surface of the molten copper." * * * "The brass founder's furnace consists of a vertical cast-iron cylinder—lined with fire-brick. The flue is led off at one side at the top, and the whole is covered with a plate having an opening of sufficient size to permit the crucible to enter, and is fitted with a cover plate. * * * Each furnace contains one crucible." * * * "In large establishments * * * the reverberatory (furnace) is generally used." Page 208, "The apparatus of the foundry * * * consists of an air or wind furnace sufficiently large enough to receive the crucible; * * * and utensils for weighing and handling the metals, fuels, and crucibles." A collection of furnaces is called a battery.

(*e*) *Some Physical and Chemical Factors of Hygienic Interest.* With the starting up of the furnace fires in the morning, if furnace ventilation is not good and particularly where coke or oil are used for heating purposes, that part of the room about the furnace area or perhaps the whole foundry may become filled with smoke and noxious fumes, which, in bad weather, may hang about in the quarters for an hour or so. Sometimes carbon monoxide gas is rich in these fumes, while at other times a very sickening odor arises from incompletely burned oil.

As to temperatures concerned ("Modern Foundry Practice," Sharp, 1900, p. 191):

Melting Points.

Steel	3250° F
Cast Iron	2750
Copper	2000
Gun Metal	1900
Brass	1834
Zinc	770
Lead	612
Tin	442

Temperatures Indicated by Color.

Welding Heat	2800°F
White Heat	2370
Orange	2010
Cherry Red	1650
Brilliant Red	1470
Dull Red	1290
Faint Red	960

As to the behavior of zinc at high temperatures ("Metallic Alloys," William T. Brannt, 1896, p. 143):

"Generally speaking, the fusing point of brass lies at about 1832° F. If brass in a fused state is kept for some time in a contact with air, its composition undergoes an essential change by the combustion of the greater portion of the zinc contained in it, which explains the change of color frequently observed in brass fused for some time in contact with air."

(And on page 168):

"In case of strong overheating of the finished alloy (brass) a considerable portion of the zinc volatilizes."

("Metal Workers' Handy Book," William T. Brannt, 1899, p. 35):

"Zinc is a readily fusible metal, it becoming liquid at 773° F. By heating it to 932° F. its affinity for oxygen becomes so apparent that on pouring it out from the crucible it burns with a splendid greenish flame and when cool forms a white flaky body—zinc oxide."

In answer to the question, "Does copper volatilize at the temperature used in making brass and bronze?" we find (Thurston's "Alloys, Brasses and Bronzes," p. 43): "The melting point of copper is given by Pouillet as 2050° F. and vaporization occurs at the white heat, the vapors burning with the green flame * * * " According to the table of temperature colors above given, white heat is about 2370° F. Brass is usually not heated above 2000° F., because of the great loss of zinc by volatilization, while, of course, 2370° F. would volatilize all the metals present. However, in the preparation of German silver it is necessary to secure a high enough temperature to melt nickel, which metal is said to melt at between 2700 and 2800° F. Consequently copper would here have an opportunity to volatilize.

It then becomes necessary to secure a very high temperature in these furnaces, whatsoever type may be used, in order to make brass and similar alloys—a temperature which is considerably above the volatilization point of some of the softer metals, and particularly zinc. If the crucibles in the ordinary cylindrical furnaces contain zinc, its fumes are emitted to the atmosphere of the room whenever the furnace is opened either to add more metal or to heap on more fuel. But it is at the time when the metals have been heated up to the proper temperature to be poured and while the crucibles containing the molten metal are being lifted out of the furnaces and carried across the foundry floor and during the pouring into the moulds that the great amount of metallic vapors arise from the metal and fill the room. This process is accompanied by a more or

less display of green flames, scintillating sparks, and deflagration of the zinc component. Out of the whitish fumes will soon be noticed small white snow-like flakes, which are largely composed of zinc oxide. It is to this whitish smoke and its sublimation products that the principal cause for sickness among brass founders is found. On this account these sublimation products have been analyzed by a number of authorities. These various authorities do not agree upon a constant composition of this metallic snow as might be expected from the inconstant composition of the alloys producing it. A typical analysis taken from "Dangerous Trades," Sir Thomas Oliver, 1902, p. 456, is as follows:

Moisture	9.64
Organic Matter	39.42
Silicious Residue	9.14
Oxide of Zinc	28.82
Oxide of Iron	2.78
Copper	1.71
Other Matter	8.49
Total	100.00

Analysis of a similar specimen by a well-known firm of chemists and assayers in Chicago was reported as follows:

Zinc	44.9%
Lead	0.8%

Others have reported the presence of cadmium, nickel, sulphur, traces of arsenic, phosphorus and other metals and acids.

The exact metal, combination of metals or salts contained in this sublimation product which is responsible for most of the sickness among brass founders has not yet been definitely determined. The majority of investigators are inclined to the hypothesis that some poisonous zinc compound arising during the volatilization of the zinc is inhaled. Others lean to the existence of some copper compound, while still others affirm that an admixture of the vapors of the two metals is responsible.

B. The Nature of the Disease to Which Brass Workers Are Subject.

Pre-eminent among the afflictions to which workers in brass foundries are subject is an acute condition known as brass founders' ague (brass chills, Giessfieber, Staubfieber, fievre des fondeurs, while the workmen use cruder terms, such as "the shakes," "smelters' shakes" and "zinc chills"). Brass founder's ague is an acute malaria-like sickness which comes on in the foundrymen or any who are exposed to the vapors which arise from the metals. Practically all recent investigators regard them as an expression of acute zinc poisoning.

The symptoms, which appear usually several hours after the pouring or after an exposure to the whitish smoke arising from the metal, are: A dry parched throat, an irritating and unproductive cough, a feeling of constriction in the chest, general lassitude, weakness and indisposition, a partial loss of appetite, sometimes a feeling of nausea and sometimes

actual vomiting. Soon after these preliminary symptoms manifest themselves a shivering sensation begins to be noticeable, usually starting in the back between the shoulder-blades, a slight dull headache develops and soon a state of apathy is reached very similar to that experienced in sea-sickness. Next follow distinct chilly sensations over the whole body, which gradually increase into a distinct rigor, which may last from a half to two or three hours, and is evinced by a severe chattering of the teeth, a shaking of the whole body and a violent tremor of the extremities. The sick person is compelled to take to his bed with the beginning of the chill and practically no amount of blankets or external heat appear to have any influence upon the severity of the chill sensation. Also there is a great desire to drink something hot and stimulating as much to relieve the parched feeling in the throat as to counteract the chill, and the workmen usually resort to whisky or brandy. Accompanying the chill there are usually pains and cramps in the muscles, particularly affecting the lower extremities. The victim feels that he is deathly sick. At the end of an hour or so the chills and muscular pains rapidly subside and are immediately followed by a most profuse perspiration, so that blankets are removed and all external heat done away with. Accompanying this there is a feeling of great relief as the dryness in the throat, the muscular pains, the headache and the nausea all cease, but the prostration continues more marked than before. This sweating stage lasts from one to several hours. In many cases it is accompanied by a distinct rise in temperature. Sometimes the temperature rises during the stage of the chill. It does not always rise and may become sub-normal. It does not usually mount high. Following the stage of perspiration the victim falls into a deep and restful sleep, from which he awakes after a few hours with usually no remaining symptoms of his recent experience other than a feeling of weakness or exhaustion, perhaps a metallic taste in his mouth and a temporary loathing of food.

Especially characteristic of the brass founder's ague, then, is the combination of a dry and parched throat, chills or rigor, great apathy, muscular pains, followed later by a period of most profuse perspiration and exhaustion. The entire attack usually lasts from five to twenty hours, seldom longer.

There are many conditions which seem to influence the onset and severity of brass chills. The newer workmen, or those who have returned to work after a week's vacation, perhaps only after a day or so off, as over Sunday, are the most liable. Unless the exposure to the metallic smoke and vapors has been unduly severe, the workman continues at his vocation all day without noticing untoward health effects. It is usually after leaving the workshop at night-time that the sickness comes on. Many state that as soon as the cold outside air strikes them the chill is inaugurated. Hence the chills are far more common in the winter-time than in the summer. Many state that while riding the street-cars home, or perhaps on removing the clothes to go to bed in the evening after a previous period of indisposition, the chill begins. The men claim that it is because they breathe more vapors in the winter-time than in the summer that chills are much more frequent in this season. This is because, in an endeavor to keep warm while at work and to keep the furnaces and moulds from "chilling," the windows, doors and skylights

are kept practically closed up; hence the fumes fail to escape through their usual routes of ventilation as they do in the summer season.

Brass chills occur almost exclusively in brass foundries, but also in foundries in which zinc, pure or with appropriate alloys, is poured. Also they occur in zinc smelters. They do not occur in iron foundries nor in bronze foundries. They also do not occur among galvanizers, the reason being obvious that in this latter process the zinc is only melted and is not heated above its point of volatilization. The method of alloying is of great influence, as the frequency of the chills, other conditions remaining the same, is almost in direct ratio to the percentage of zinc contained in the alloys.

About seventy to eighty per cent only of workmen seem susceptible to the metallic vapors and experience the chills. Hence some natural immunity seem to exist. Also a tolerance occurs in about seventy to seventy-five per cent of workmen who work steadily at the trade. A further twenty to twenty-five per cent sicken more or less regularly, but usually not severely. Only in very rare cases do these attacks occur so continually that a change of occupation is necessary.

All factors which tend to lower natural vitality are predisposing to brass chills, especially alcoholism, poor quality of food as is consumed by a large proportion of the foreign workmen, irregular hours, and excesses of all kinds. In addition weak, anemic individuals, young persons, and women are more subject to brass chills than robust and strong individuals.

In large foundries with good ventilation, either natural or artificial, brass chills practically never occur. Precautionary measures, such as sponges, respirators, etc., have a restricted value, but are generally little and reluctantly used.

No specific medical treatment has hitherto been discovered. As Dr. Theodore Weyl, in his "Hand-Book of Trade Diseases," says:

"The moulders consider the fever so commonplace and matter of course—only a few having been exempt and many have had it as much as one hundred times and more—that they do not go or send to the physician on account of same. At all events physicians, on this account, have rarely had the opportunity of observing brass founder's ague."

Most of the workmen resort to whisky, although very few declare that it is antidotal. It is simply a traditional remedy. The more careful and observing workmen use mild emetics, since they claim that the production of vomiting relieves the chilly sensations at once, while a good purge seems as beneficial as anything. Many of them seem to derive some benefit from drinking hot milk, to which they often add pepper.

A single attack of brass chills is in itself not dangerous, and as they come on usually at night-time the workmen rarely lose any time from work, at most not more than the day following the chill. Once back at work they become rapidly inured and no longer subject to the chills. But the constant repetition of these chills, or the constant exposure to the

conditions producing them, ultimately ends in chronic diseases, usually affecting the lungs, digestive tract, nervous system and kidneys. Sir Thomas Oliver, in his book on "Dangerous Trades," 1902, p. 457, states:

"Brass founder's ague * * * is only an acute expression of a chronic malady, and one which rarely or never comes within the range or experience of practicing physicians. In the out-patient department of the Birmingham (England) hospitals one meets with enormous numbers of brass workers complaining of various pulmonary and gastric disorders; but an experience of many years has never yet produced to us a case of this so-called ague, although questions will very frequently elicit the statement of its occurrence."

On page 135 the same author gives a Comparative Mortality Table, in which various trades are compared with that of the agriculturist. This shows that brass workers' mortality is at the rate of two and one-half times that of the farmers, and that respiratory diseases, particularly tuberculosis, is the pertinent cause.

In addition to brass-man's ague, the peculiar affection, and to respiratory diseases, older brass workers suffer from a long list of digestive diseases centering about chronic dyspepsia, biliousness and gall-bladder diseases; often they are slightly jaundiced, with obstinate constipation, at times diarrhœa and hemorrhoids. Also a disease of the gums, called pyorrhœa alveolaris and carious teeth, are common among them. Finally the frequency of anemia and general appearance of ill-nourishment and emaciation is so prevalent among them as to have been given a special place in our tables which follow.

Historically considered, the brass trade has always had an ill-repute from a health standpoint, even from the time of the ancients. The affection known as brass founder's ague was confused with malaria until the year 1830, when an Englishman, Thackrah by name, first described it as a separate affection peculiar to brass workers. In 1845 it was recognized and described by Blaudet, in France. In 1858 Greenhow, in England, on the basis of his researches, came to the conclusion that "Brass pourers and doubtless all workmen who deal with zinc vapors are easily attacked with a disease similar to an intermittent fever of irregular type." In Germany, Schnitzer was the first to call special attention to brass chills, in 1862. In 1906 J. Sigel,* in Wurttemberg, Germany, sums up the entire literature concerning this peculiar malady and adds the results of his own investigations, principal among which was the demonstration of zinc in the urine after a brass chill. The literature upon the entire subject is very scarce. In America a few articles have appeared in recent years, usually reports of individual cases, among them being one by Drs. Moyer and Lavin, of Chicago, in 1904; also one by Dr. S. R. Pietrowiecz, of Chicago, in 1904. The disease, as well as chronic symptoms of brass workers, is also commented upon by George M. Kober, of the President's Home Commission, 1908.

*Dr. Julius Sigel: *Das Giessfieber und seine Bekampfung mit besonderer Berücksichtigung der Verhältnisse in Wurttemberg.* -Vierteljahrschrift für gerichtliche medizin und öffentliches sanitätswesen. (Juli, 1906, und Oct., 1906). Dritte folge, XXXII Band, 174, 384.

The finishing processes upon brass castings may also be associated with some diseases. These processes consist of turning, filing, skimming, burnishing, grinding, polishing and buffing, all of which produce dust. The diseases found in these trades are bronchitis, bronchial catarrah and pulmonary tuberculosis. It does not appear that the metallic dust particles of brass and similar alloys are any more poisonous in themselves than any other metallic dust, but that their presence in the respiratory tract, continually, produces chronic irritating diseases which predispose to the onset of consumption. An exception, of course, must be made where these dusts contain lead particles.

The effect of the brass trade upon longevity may be summed up in the following quotation from Sir Thomas Oliver's "Dangerous Trades," 1902, p. 461: "Only ten brass workers out of 1,200 casters in Birmingham (England) were found living beyond sixty years. A superannuation insurance for brass founders to begin at fifty-five years of age had only three applicants in a period of some ten years."

Part II.

A. The investigation here reported was originally intended to include the brass manufacturing industry only, but, because of the large extent to which similar alloys and metals are used in association with the manufacture of brass by the same workers, it has been thought best to include those in this report. The "non-ferruginous metal-workers" is the term commonly applied to this industry.

The *general scope of the non-ferruginous metal trades,* exclusive of lead, tin and mercury, in Chicago and Cook county, Illinois, may be roughly ascertained from the United States Bureau of Census Reports, given below. These trades center about the Brass Manufacturing Industry.

In Bulletin No. 52 of the Bureau of Census, United States Department of Commerce and Labor, p. 32, is the following table (abbreviated):

Manufactures by Specified Industries, Illinois, 1905.

Industry—	*Number Establish.*	*Capital.*	*Wage Earners.*	*Yr. Wages.*
Brass	3	$ 90,406	25	15,742
Brass castings and finishing	31	2,314,789	975	577,259
Brass ware	24	1,024,941	605	326,163

There are no zinc or bronze industries specified, while copper-smithing is included with sheet iron workers. In galvanizing, five establishments are mentioned with fifty-five workers. Electro-plating has twenty-six establishments with 272 workers. It is very probable that these reports do not include many large establishments which engage in these trades as necessary adjuncts to their businesses, but whose finished products cause these trades to be lost sight of in classification. In the same bulletin there is a similar table for Chicago, 1905:

Industry—	*Number Establish.*	*Capital.*	*Wage Earners.*	*Yr. Wages.*
Brass	3	$ 90,406	25	15,742
Brass castings and finishing	19	1,251,605	415	270,397
Brass ware	21	598,182	449	247,586

Both of the above tables are also found in Special Reports of Census Office, Manufactures, 1905, Part II.

In the Twelfth United States Census, 1900, Table 43, p. 518, under Occupations, Chicago, all brass-workers are grouped together, there being 1,566 men, no women, 811 married, 3 negroes. Age periods show:

10-15 years.	*16-24 years.*	*25-44 years.*	*45-64 years*	*65 years.*
42	474	857	186	7

Under *"Localization of Industries,"* Special Reports of the Census, Manufactures, 1904, Part I, pp. cciv, we read:

"The manufacture of brass goods in their various forms, shown in the Census Reports under the class 'brass and copper rolled,' 'brass casting,' 'brass finishing,' and 'brass ware,' is and has been for many years, according to statistics, an industry controlled largely by Connecticut manufacturers. The value of this class of goods in 1905, $99,083,837 for the United States, shows $53,916,445, or 54.4 per cent, for Connecticut."

Table V, same reports, Group 10, shows Illinois to rank about fourth in the industry, the order, based on capitalization, being: Connecticut, New York, Pennsylvania, Illinois, New Jersey.

The *smelting* of the ores containing copper, zinc, tin, and aluminum are practically unknown industries in Cook county, and, with the exception of zinc, in the entire State of Illinois. In Special Reports on Selected Industries, Department of Commerce and Labor, Bureau of Census, Manufactures, 1905, Part IV, Table 6, p. 105, it is to be noted that, although Illinois had one copper-smelting and refining company in 1900 included in "all other States," none is reported in 1905. The extent of Illinois zinc smelting is shown in the same report, Table 37, p. 123:

Census—	*No. Establish.*	*Capital.*	*Wage Earners.*	*Wages.*
1905	5	2,876,201	1,643	883,504
1900	5	2,186,319	1,551	758,912

"The production of the Illinois (and Missouri) zinc smelters shows a decrease at the census of 1905 over that of 1900."

The Commissioner of the Chicago Brass Manufactures Association, 1112 Schiller building, Chicago, states that there are about 2,000 employees working inside of brass foundries alone in Chicago at present. The number in past years has been as high as 4,000, but the advent of machine moulding has made the difference.

The re-melting, alloying, casting, plating and finishing processes on these metals are, then, all that concern the investigator in the city of Chicago.

B. Summary of Chicago Brass Foundries.

I. As to general statistics.

There were eighty-nine firms visited which are engaged in the brass foundry or refining business in Chicago, leaving not more than a dozen small concerns employing less than half a dozen moulders unvisited.

Dates of Inspection. All these foundries were visited between June 10 and September 1, 1910. In addition, a large number of firms working on brass goods and parts other than founders were also visited. These are included in Part II, C, of this paper.

The total number of all firms visited is 182. Of these eighty-nine were concerned in foundry or refining work. A summary of these is here made.

Quarters Occupied by Brass Founders, Smelters and Refiners. Of the eighty-nine concerns visited sixty-eight are of enough magnitude to have at least one or more buildings. This does not imply that these buildings are concerned solely with brass foundry work, but that the concern at the place where the brass foundry is located has at least one building for manufacturing purposes. Of the smaller concerns which are engaged in the foundry business six occupied part of a building, eight one floor in a manufacturing building and seven only part of a floor or a room for their foundry purposes.

Time of Establishment. These firms date back to 1852. Dating back for from forty to fifty-five years are six large concerns. There are nineteen more firms established over twenty years.

In their whole works these various firms employ from one man, occasionally, to 12,000 individuals at one and the same plant.

Women in Factories. Twenty of the eighty-nine firms visited employ women. In one concern this was not especially investigated.

Women in Brass Foundry Work. There are three large concerns employing women in their brass foundries in rooms only partly partitioned off and directly exposed to the vapors and fumes and general atmosphere of the foundry. In addition there are three large firms employing women in their brass foundry work in rooms partitioned off in one corner or at one end of the foundry. In all cases these women are occupied at making cores, wherein they handle moist sand and dirt and usually sit at long benches. The work cannot be regarded as particularly unhealthy, unless the women and girls so employed are subjected to the noxious vapors of the foundry-room.

Proportion of Skilled Labor. This was inquired into at each firm visited, but the various specialties of these firms were so great that summarizing figures on this statement are of doubtful importance. As to the foundry work, its statements will follow later regarding the various proportions of workmen skilled and unskilled at various processes.

Labor Policies. Regarding unionism and organized labor, an inquiry was made at each firm, with the following deductions: Of the eighty-nine firms twelve were claimed by the officials thereof to be union, six employed only union labor but had no closed shop policy, fifteen were strictly non-union, fifty-three were open shop, and three may be classed as mixed, that is, they employ union labor in certain processes wherein proper labor is difficult to secure, as, for instance, teamsters, but not in other processes.

Specialties. Of the eighty-nine firms doing foundry work there are jobbers, 36; chandelier manufacturers, 8; plumbing supply manufacturers, 5; valve manufacturers, 2; smelters and refiners of old scrap metal, 9; manufacturers of journal bearings for cars, 5, and those engaged in the manufacture of some particular specialty, 25. The importance of these various specialties lies in the one which concerns the

composition of the brass or similar alloys made. The alloys which are most detrimental to the workman's health from inhalation of vapors are German silver, so-called white metal, yellow brass, and all compositions with a high zinc component. Practically all the jobbing concerns make more or less German silver, as do also chandelier makers, plumbing supply concerns, valve concerns, smelters and many of the specials. Those particularly concerned in the manufacture of yellow brass articles are chandelier makers, plumbers' supply house, soda-fountain manufacturers, smelters, and many of the specials, as well as the jobbers. Those making rich zinc compounds at high temperatures are limited in number because of the great loss from the burning up of the metal, as well as the fact that the workmen cannot stand the vapors and fumes produced. Smelters are practically the only ones so occupied. Manufacturers making red brass, commonly known as bronze, include many of the jobbers, plumbing supply concerns, valve concerns, journal bearing manufacturers and the specials. Red brass or bronze is the most expensive of the alloys. Also in its manufacture the least amount of fumes is produced. This is because the zinc component, which is cheap, is minimal in the composition. Many of the jobbers refuse to manufacture "cheap yellow brass articles." By far the largest manufacturers are those engaged in the manufacture of journal bearings for railroad cars, where hundreds of men are employed in the foundries. These bearings are a very good bronze composition, but still enough zinc is put into the alloy to render the atmosphere of such foundries often the cause of great complaint among the workmen there employed.

Processes Engaged In. Of the eighty-nine firms inspected twenty-one were found to be founders only, twenty made founding their main specialty, although they did some further finishing-up processes in addition, while with thirty-nine concerns their brass foundry was only an accessory to their general manufacturing business. Among the latter some of the largest brass foundries in the city are found. Finally there are nine concerns engaged in the smelting and refining of old scrap metal to such an extent as to run their works continuously.

II. FOUNDRY QUARTERS.

Location of Foundry. The total of eighty-nine foundries had the following locations:

A special foundry building, 26.
One-story building, 30.
On top floor, 48.
On mid-floors, 3.
First floors, 8.
In basements, 4.
In addition 3 located in half-basements.

Of the special buildings practically all are one-story. The special buildings for foundry purposes do not correspond at all to any one type or plan of construction. They vary in their age of construction from those just constructed during the summer to others which appear to be thirty-five or forty years old. Many of the special foundry buildings of one-story height are worse situated as regards ventilation than are other foundries upon top floors, because of surrounding buildings. Those

located on mid-floors, first floors and basements are, of course, the poorest situated as regards ventilation. In the above table the item "one-story buildings" duplicates the other places of location in most instances, so that the apparent total in the table is thirty greater than the number of firms inspected.

Surrounding Buildings of the Eighty-nine Foundries. Forty-five are so situated that surrounding buildings interfere with whatever natural ventilation they have, while in addition three more are questionably so located.

Arrangement of Foundry-Rooms. The main feature concerning the hygienic arrangement of a foundry is the separation of various processes into separate rooms or compartments so that not all the workmen need necessarily be exposed to the dangers arising from any particular process. To ascertain how thoroughly this arrangement has been carried out in the foundries of Chicago the investigation resulted in the following findings:

Firms having separate furnace-room, 6.
Firms having separate core-making room, 12.
Firms having all foundry processes in one room, 71.
Total, 89.

Firms having other than foundry processes in the foundry-room, 23, or about one-fourth of the total firms.

Size of Foundry Quarters. An inquiry was made at each place to determine whether the cubic feet of air space per man was great enough. Without exception no foundry was discovered with too little cubic air space, although a few were evidently too crowded for the magnitude of the business transacted. Also it is quite evident that foundries should not have their cubic air space measured on the same basis as that for a living room or school-room, visibly 500 cubic feet of air space per person. This latter was the basis upon which the above statement is made for foundries.

Ventilation. 1. The character of the ventilation in the eighty-nine foundries has been summed up as follows:

Good, 37.
Fair, 20.
Poor, 25.

The above tabulation means the obvious confinement of fumes and gases within the quarters as seen during the summer season, that season when natural ventilation is the best, because of open windows and doors, with a thought in the background always of what the conditions must be in the closed-up wintry season.

2. Windows. The number of sides of the foundry-room having windows was also ascertained with the following results:

Foundries having windows on one side only, 9.
Foundries having windows on two sides, 46.
Foundries having windows on three sides, 24.
Foundries having windows on four sides, 14.

3. Doorways available for ventilation:
Foundries having one such doorway, 35.
Foundries having two such doorways, 14.
Foundries having three such doorways, 4.

4. Roof Ventilation. Of the eighty-nine firms, seventy-five had some form of roof or ceiling ventilation.

5. Artificial Ventilation, as suction fans, blow fans, etc. For the entire foundry quarters of the eighty-nine foundries, only nine so provided, and almost without exception these very inefficiently so.

6. Adequate Ventilation, especially as regards any sort of inclement weather. Only twenty-two firms could be said to have anything like adequate foundry ventilation under such circumstances and none of these could be considered better than fair.

Light. Light was ascertained as good, fair or poor:

Good, 50 foundries.
Fair, 21 foundries.
Poor, 17 foundries.
Artificial, 1 foundry.

Total, 89.

Temperature:

Good, 38 foundries.
Fair, 18 foundries.
Unduly hot, 25 foundries.
Eight foundries not running at time inspected.

Total, 89.

Cleanliness (whitewashed walls, absence of excess dirt, dust, and so on):

Good, 30 foundries.
Fair, 35 foundries.
Poor, 24 foundries.

Total, 89.

Heating Facilities. Unfortunately, this was not thought of early enough in the inspection to get a summary for all the foundries, but suffice it to say that nearly one-half depend upon soft-coal stoves for general room temperature in the winter-time and not a few upon salamanders.

Height of Roof, Clear, Feet:

Foundries with 10-foot ceiling, 4.
Foundries with 12-foot ceiling, 22.
Foundries with 14-foot ceiling, 19.
Foundries with 16-foot ceiling, 19.
Foundries with 18-foot ceiling, or more, 16.

Total, 80.

Type of Roof, whether flat, gently sloping or pitched.

Flat, 65 foundries.
Sloping, 15 foundries.
Pitched, 9 foundries.

Type of Roof Vents:

Lift Windows, 11 foundries.
Trap Doors, 21 foundries.
Cupolas, 10 foundries.
Monitors, 15 foundries.
Saw-teeth, 10 foundries.
Texas, 11 foundries.
Special, 7 foundries.
Absent, 13 foundries.
Adequate, 22 foundries.
Fairly adequate, 11 foundries.
Entirely inadequate, 50 foundries.

Eating Quarters:

Usually in the foundry-room, 88 foundries.
Other rooms available, 57 foundries.
Special room provided 2 foundries (one of the latter by no means large enough).

Wash-up Places for Convenience of Workmen:

Located in foundry-room at 50 foundries.
Practically in foundry-room at 8 foundries.
In a separate or in a different compartment at 21 foundries.
Buckets only at 50 foundries.
Buckets usually at 5 foundries.
Washbowls at 3 foundries.
Inadequate washbowls at 5 foundries.
Sinks or wash troughs at 31 foundries.
Sinks or wash troughs inadequate at 6 foundries.
Hot water at 12 foundries.
Hot water not provided but available at 10 foundries.
Soap provided at 7 foundries.
Soap workmen furnish at 5 foundries.
Towels provided at 3 foundries.
Towels workmen provided at 5 foundries.
Shower baths at 4 foundries.
Adequate provision found in only 5 foundries.
Fairly adequate provision found in 17 more foundries.

Location of Toilets. This was also not determined in the case of some of the foundries at the beginning of the investigation, but a total of six were found to be practically in the foundry-room exposed to the atmosphere of the foundry, while thirteen were only inadequately partitioned off.

Location of Furnaces:

1. In a separate room, 4 foundries.
2. In one place only 77 foundries. In two different parts of room or building, 8 foundries. In three different parts of room or building, 2 foundries. In several parts of room or building, 2 foundries.
3. In center of room, 13 foundries.
4. In corner of room, 34 foundries.
5. Along a wall, 76 foundries. (Many of these are also toward one corner of room.)
6. Having windows behind or above the furnaces, 19 foundries. (In some places this is considered an advantage in point of ventilation, but is very questionably so.)

Batteries of Furnaces:

75 foundries had only 1 battery of furnaces.
9 foundries had 2 batteries.
3 foundries had 3 batteries.
2 foundries had several batteries.

Furnaces in Each Battery. These vary from one to fifteen, the general average being six to eight. Such batteries may consist of simple old type cylindrical crucible furnaces or of giant oil blast tilt furnaces, the former having one to 200 pounds' capacity at a time, the latter one to four tons' capacity.

Type of Furnaces as to Location on Floor:

Batteries entirely above floor, 37.
Batteries one-half pit, 10.
Batteries, pit, 50.

Crucible Hoist. This means the manner of raising the crucibles containing the molten metal out of the furnace pots:

By hand, 60 batteries.
By machine, 31 batteries.

Crucible Carrying. This means the method of transporting the crucibles containing the molten metal from the furnaces to the moulds:

By hand, 67 batteries.
By machine, 18 batteries.
Undetermined, 6 batteries.

Size of Crucibles. These vary all the way from 15 pounds to 675 pounds' capacity. The main thing to determine is whether very heavy crucibles have to be raised up out of the furnace pots by hand and carried by hand or whether some form of machine hoist and carriage is provided. It was found that by dividing the crucibles used into small, medium and large there were thirty-eight firms handling large size crucibles with capacities from 180 pounds up. Consequently it will be

seen that there are a larger number of concerns handling large size crucibles than there are concerns or batteries having machine hoists and carrying apparatus, so that in not a few cases workmen are subjected to great strains also while exposed to excessive heat, vapors, accidental injury, etc.

Type of Fuel:

Hard coal, 53 batteries.
Coke, 26 batteries.
Oil, 21 batteries.
Gas, 1 battery.

Nature of Furnace Draft:

Natural draft at 16 foundries.
Artificial blast at 63 foundries.
Undetermined at 12 foundries.

The point to this is that there are sixty-three foundries provided with fans for driving or sucking the air through the furnaces out of the eighty-nine inspected. Might not more of these install a little larger fan for room ventilation purposes also?

Types of Furnaces used:

Cylindrical stove, 74 batteries.
Fisher oil blast, 14 batteries.
Swartz down-draft, 5 batteries.
Harvey oil blast, 3 batteries.
Anderson oil blast, 1 battery.
Rockwell oil blast, 1 battery.
Reverberatory, 2 batteries.
Cupola, 2 batteries.
Special brick kiln (oil), 1 battery.
Retorts, 1 battery.

Ventilation Provisions about the Furnace Area:

Skylight above, 53 foundries.
Skylight not far away, 10 foundries.
Canopy over furnace area, 3 foundries.
Very small hood and stack, 5 foundries.
Hood and stack over furnace area, 9 foundries.
Apron and skylight, 6 foundries.
Special suction fan, 6 foundries.
Small electric blow-fan, 2 foundries.
Adequate ventilation for furnace area, 4 foundries.
Fairly adequate, 13 foundries.
Absent altogether, 14 foundries.
Practically absent, 4 foundries.
Inadequate, 72 foundries.

Ventilation about Furnace Area when Visited:

Good, 23 batteries.
Fair, 18 batteries.
Poor, 40 batteries.
Not running, 9 batteries.

Temperature about Furnace Area:

Good, 19 batteries.
Fair, 19 batteries.
Poor, 43 batteries.
Not going, 9 batteries.

Metallic Flames Pouring into the Room Atmosphere from Furnaces:

Continuously, 30 foundries.
At intervals, 50 foundries.
Not running, 9 foundries.

Frequency of Pouring of Metals:

Pouring practically continuous all day, 31 foundries.
Pouring two to four times daily, 58 foundries.

Character of Crude Metal Used for Melting Up. In no foundries were virgin ingot metals exclusively used. Practically all foundries use a certain amount of scrap metal, varying from one-fourth to entirety, while the large majority use from one-third to one-half. Also the so-called ingots or pigs of virgin metal which they buy are in themselves of very uncertain composition, since they usually come from the smelters and refiners of scrap metal, who in a very rough sort of way attempt to discover the percentage composition of the ingots and pigs they turn out for sale. In only two smelting works were chemists found who determine the percentage composition of metal for sale.

Character of Products Made in Various Foundries:

Largely yellow brass, 34 foundries.
Largely red brass or bronze, 37 foundries.
Considerable German silver, 16 foundries.
Considerable aluminum, 5 foundries.
Any and all compositions, 68 foundries.
Undetermined in 2 foundries.

IV. PERSONAL STATISTICS AT FOUNDRIES.

Employees in Foundry. These may be divided into moulders, furnace-men, core-makers, laborers, including grinders and those at ulterior processes. Practically only totals are important here, since nearly all the workmen in a brass foundry are exposed alike, for most of the metallic vapors which are responsible for most of the sickness arise from the pouring processes, and such vapors invade the whole room. The total employees in brass foundries was found to be 2,212, of whom 451 are at ulterior processes and should be in separate rooms entirely, leaving 1,761 foundry-men in the eighty-nine foundries inspected. Above figures of the division of these workmen are not available for totals, since at first these were not ascertained for each shop, but the divisions are the same in all foundries and are exemplified as follows for a foundry employing twelve men:

Moulders, 7 men.
Furnace-tender, 1 man.
Core-makers, 2 men.
Laborer (grinding), 1 man.
Total, 12 men.

In some routine foundry work much of the moulding is done by machines, so that the proportion of moulders drops off. Also in some foundries of like nature the number of core-makers drops off. This is particularly so where large castings of one routine type are made. In foundries where large castings are made the percentage of laborers is also increased considerably in proportion.

Nationalities. These were ascertained as follows:

A large proportion American, 42 foundries.
A large proportion English-speaking, 63 foundries.
A large proportion Polanders, Bohemians, etc., 45 foundries.
A large proportion Scandinavians, 7 foundries.
A large proportion Italians, 2 foundries.
Greeks, Hebrews, each, 1 foundry.

Officials Consulted and Their Statements. There were a total of 114 officials consulted, representing eighty-three foundries. Their statements have been considered as evidence for or against the existence of occupational diseases among their own employees or as particularly interesting in the following proportions:

Positive (diseases in their own plants), 31 officials.
Negative (diseases in their own plants), 46 officials.
Interesting concerning brass-workers' diseases, 26 officials.
Those making no comments of interest, 11 officials.

Workmen Consulted While at Work in Their Plants Regarding Occupational Diseases. There were 187 of these, representing seventy-eight plants. Of these workmen 146 complained of trade sickness or diseases. From the first it was thought wise to ascertain whether these workmen were consulted in the presence of an official or not, inasmuch as this circumstance might have much to do with their evidence. Of these at fifty-five plants the workmen were consulted in the presence of officials. Their testimony may be stated as follows:

Positive at the plants where they work, 40 plants.
Negative at the plants where they work, 38 plants.

Of the latter, nine, however, gave very interesting information, though not directly blaming their own plants.

Forms of Sickness Complained Of:

Brass chills, 45 foundries.
Smoke inhalations, 26 foundries.
Other acute sicknesses, 4 foundries.
Other chronic sicknesses, 20 foundries.
Temperature variations, 11 foundries.
Fatigue, 3 foundries.

Appearance of the Particular Workmen Consulted:

Anemic, 45 foundries.
Ill-nourished, 29 foundries.
Emaciated, 13 foundries.

Years of Age of Oldest Men. Of the first twenty firms visited oldest man, 53 years; of the second twenty firms visited, 66½ years; of the third twenty firms, 53 years; of the fourth twenty firms, 67 years; of the fifth nine firms, 73 years.

Years Longest at Trade:

Of the first 20 firms, 1 man 35 years.
Of the second 20 firms, 1 man 44 years.
Of the third 20 firms, 1 man 30 years.
Of the fourth 20 firms, 1 man 52 years.
Of the fifth 9 firms, 1 man 53 years, but not regularly.

Years Longest at Present Firm:

Of the first 20 firms, 1 man 35 years.
Of the second 20 firms, 1 man 19 years.
Of the third 20 firms, 1 man 22 years.
Of the fourth 20 firms, 1 man 34 years.
Of the fifth 9 firms, 1 man 21 years.

Number of Men Over Fifty Years of Age. Total, 17.
Number of Men Over Forty-five Years of Age. Estimated, 60.
Number of Men Over Forty Years of Age. Estimated, 180.

The above figures are taken from the 1,761 foundry-men.

At forty-four foundries workmen also complained of conditions at other firms where they had previously worked.

Of the Eighty-nine Foundries:

63 were acknowledged as the centers of trade sickness, either by workmen employed in such foundries or who had previously been employed in such foundries, or by officials themselves.

7 were so decidedly racial or "family managed" that neither workmen nor officials would acknowledge existence of trade sickness, though all were hygienically among the poorest-arranged foundries in the city.

6 were new concerns which had not yet experienced a winter season to demonstrate the efficiency of their ventilation system.

4 were small concerns employing two men or less.

5 were doubtfully well enough ventilated to prevent disease; at best no complaints received.

4 had no complaints lodged against them and were undoubtedly hygienically well enough equipped to prevent industrial diseases.

C. Summary of the Processes Supplemental to Brass Founding. General Statistics.

These processes are usually termed the finishing processes and may be divided into—

1. Grinding.
2. Polishing and buffing.
3. Plating.
4. Lacquering.
5. Tool and machine work.

Location of Concerns. As before mentioned, many of the brass founders are also engaged in the finishing processes. In fact, practically all brass founders do some grinding in order to finish up their castings to a certain extent and to save for re-melting the "gates" or tag ends of metal which result from each casting. In addition, a large number of firms are engaged in polishing, buffing and plating processes, some others in lacquering and some in all of these processes plus tool and machine work. These concerns are located in all manner of factory quarters, from portions of single small rooms to the occupancy of large buildings.

Number of Firms Investigated. No attempt was made to cover this field, but while investigating the brass foundries the departments engaged in the above-mentioned processes were also visited, while many firms listed as under brass manufacturers were visited as well.

Number of concerns visited engaged in polishing and buffing, 58.
Number of concerns visited engaged in plating processes, 30.
Number of concerns visited engaged in lacquering, 14.
Number of concerns visited engaged in tool and machine work, 61.

In the above concerns the number of employees were:

At polishing and buffing, 584.
At plating, 251.
At lacquering, 70.
At tool and machine works, 1,220.

Women in such factories:

At polishing and buffing, one factory, 35.
At plating, none.
At lacquering, 4.
At machine work, 27. (These were usually engaged in some assembling process.)

Labor Policy. It was found that a large majority of the polishers and buffers are unionized; that only a small part of the platers and lacquerers were unionized; that nearly all of those engaged in machine and tool work were unionized, while those engaged in assembling processes were usually unskilled labor.

Quarters. A general statement may be made to cover all the above processes that the quarters occupied were in general keeping and appearances equal to those of the balance of manufacturing concerns in the city. In only a few establishments were polishers and buffers, platers,

lacquerers or machine workers found established in basements or particularly unhealthy locations, while it is true that many of them were located in poorly-lighted rooms.

Ventilation. As this is the main hygienic feature concerning all of these processes, each will be taken up separately:

Polishing and Buffing. Of the fifty-eight concerns visited it was found that all those employing more than one man at either of these processes had machines equipped with an air suction system according to the legal requirements. It is true that in certain establishments these were not in working order at the time visited, that the suction force in some concerns was evidently not great enough to carry away the metallic dusts which were arising from the emery wheels, cloth wheels, belts, etc., and that occasionally some "blower" system was actually found plugged up with dust and therefore its utility temporarily *nil.* As this process, however, is well enough regulated by law the usual artificial ventilation will not be further discussed. The breathing of the dust created in the process is the dangerous feature. Of thirty persons engaged at polishing and buffing who were questioned, all who worked on machines equipped with the air suction system had no particular complaints to make, although some appeared rather anemic. Only occasionally, where one man was employed at the process without sufficient protection or perhaps with no protection from the dust, was there complaint. Seven such individuals were seen. They usually did not work at the process but a few hours at a time. Everywhere the general comment was made by the workmen that polishing and buffing has become a comparatively healthy and agreeable occupation since the installation of the air suction system to remove the dusts. Sometimes these dusts cause other affections which are minor in importance, such as a mild skin inflammation or "brass itch," as the workmen style it, which is more prevalent in the summer-time and is usually ascribed as due to personal uncleanliness. In addition it was no uncommon thing to find all those who were engaged in any dust-producing work upon brass, copper and similar metals to have a green tint to the hair, perhaps a greenish coating upon the teeth, and to comment upon the fact that they often perspired green even after taking a thorough bath. However, all such persons consulted had no associated physical complaints. I found many older men engaged at this process than at brass founding. Many of these said that previous to ten or twelve years ago, when the present air suction systems were installed, they were subject to chronic coughs and sometimes asthma, but in most cases this had entirely cleared up since, so that very few such complaints are made nowadays.

Plating. Of the 251 employees seen at this process, some thirty were engaged at dipping of castings into concentrated mineral acids and alkalis in order to cleanse them preparatory to plating. At all establishments where two or more persons were constantly engaged at this process, efficient hoods and air blasts were found to draw away the fumes from the neighborhood of the workmen, but in twenty-four concerns where this process was only engaged in a few hours at a time no hoods or means of removing the fumes were provided.

Of the thirty plating firms visited, twenty-seven had processes requiring large tanks of weak potassium cyanide solutions, of which seventeen

employed them at a temperature of about 110° F. Of these firms only three were provided with any means of removing fumes which might arise from the tops of these open cyanide tanks. Of the 251 persons engaged at plating, seven were found who complained of having had cyanide ulcers from being compelled to dip their hands into these cyanide solutions, while two men actually complained of the effect of the cyanide upon their health. Also two officials in two of the largest concerns stated that all such cyanide tanks should be provided with hoods and other means of efficient ventilation. Cyanide solutions are slowly solvent, depending upon their concentration and temperature, hydrocyanic acid being slowly given off.

Many other poisonous compounds enter into the plating process, chief among which is arsenic, used to produce a black plate effect in certain ornamental work. However, this is a process which requires the experience of an expert and usually the foreman of the department has it in charge personally. It is also only occasionally done even in the largest plants, and no evidence of arsenic poisoning could be found. Of the 251 platers seen, seventeen complain of chronic or recurring rheumatism, which they declared was due to standing upon wet floors or to placing the hands and arms in and out of the various solutions used. Careful inquiry was made regarding the occurrence of lead poisoning but with negative results.

Lacquering. Of the fourteen firms engaged in this process it was found that only three did lacquering by spraying the lacquer upon the article to be coated. By far the usual process is that of brushing the lacquer upon the article or of dipping the article into the lacquer. Lacquer rooms are usually very closely confined quarters, because the least draft or air current raises enough dust to spoil the effects of the lacquer. Consequently the fumes of the lacquer are usually quite strong and make one cough upon entering the room. By far the usual solvent used is amyl acetate, and the pleasant odor of this fills the room. No cases of actual sickness could be found traceable to the effects of lacquering or its fumes, although two or three officials said that some persons were so nauseated by the fumes that they could not stay at this kind of work. Sometimes it was claimed that wood alcohol and benzine were used as solvents for the lacquer, but in no place visited could direct evidence of this be discovered. Many concerns employ girls or women at lacquering. They work at long benches, usually brushing the lacquer upon the article to be coated. No definite cases of trade diseases could be discovered among them.

Tool and Machine Work. This process may also be made to include all assembling processes upon brass parts. Here the danger to health is as minimal as in any process of brass manufacture, for the dust produced is small, while the borings are so heavy as not to get into the atmosphere. Considerable work is also done as brazing parts together with brass solder. These workmen stand over forges, but at no place were the metals heated high enough to volatilize the zinc, while the most disagreeable feature was the breathing of the coal gases and the temperature. However, of eighteen brazers no cases of trade sickness could be discovered.

D. Lead Poisoning Among Brass Workers.

With the point in view of definitely determining to what extent brass workers may suffer from acute or chronic lead poisoning, since practically all the alloys they make up contain from traces to 6% or 7% of lead, a symptomatic and requisite physical examination was made of thirty-seven representative brass moulders of all ages who were assembled at one of their union meetings and were from various shops all over the city. From this number the following was determined:

Symptoms:

Chronic headaches, 7 men.
Recurrent abdominal cramps or colics, 6 men.
Constipation, said to be obstinate, 25 men.
Metallic taste in the mouth, 5 men.
Fainting spells, fits, dizziness, no men.
Loss of appetite, no men.
Nausea or vomiting (alcoholism?), 11 men.
Blind spells, 1 man.
Paralysis or weakness of wrist, no men.

Physical Findings:

Lead line on gums (this only suggestive), 1 man.
Anemia, 10 men.
Ill-nourished, 11 men.
Both wrists weak upon extension (these questionable), 2 men.
Diseases of the gums (all degrees), 9 men.
Teeth in poor condition, 8 men.

From the above, although alleged symptoms which may be taken as significant of plumbism are common, the absence of the lead line (which should be present in the younger men, if among any of them, and which is the most constant of the specific findings of lead poisoning) and the fact that none of the cases presented a combination of enough of the above stated symptoms and physical signs to make a diagnosis of lead poisoning, it may be stated that lead poisoning among Chicago brass founders is uncommon. These men were all skilled moulders or furnace men working in brass foundries. They do not include those men who work in refining and smelting plants where usually lead is the principal metal concerned. They also do not include some supplemental brass and bronze processes, such as the lining of journal bearings for railroad cars, which is largely lead work. Also it does not include laborers who are engaged in junk houses at sorting old scrap metals, nor laborers who are engaged at the pounding up of sheet scrap metals into moulds in the production of "Cabbages," in order to render such forms of metal better capable of being handled.

PART III.

The LaSalle County Zinc Smelters.

Inasmuch as zinc is so bound up in the manufacture of brass and, as was stated at the conclusion of the part headed "General Scope of the Brass Industry in Chicago," that there were no zinc smelters in Chicago, it was considered advisable to search the large zinc concerns of LaSalle county, Illinois, for evidence of diseases similar to those

affecting the brass workers in Chicago. Such evidence was especially necessary since the volatilization of the element, zinc, is blamed for most of the diseases affecting brass workers. There are some firms listed in Chicago as smelters of zinc, copper, etc., but these concerns are really refiners as they receive no crude ores whatever for smelting and such work as they do in this direction is the regaining of zinc, copper and tin from furnace ashes, old crucibles, etc.

Location. The zinc smelters visited are located along the Illinois River valley, all within a comparatively few miles of one another, and are established here because of the coal fields solely, for there are no zinc mines in this vicinity. Of the three concerns visited, one of these is located at the exact edge of the river in the river bottom, the other two upon the neighboring hillsides or benchlands. The oldest of these concerns was established in 1858; the youngest in 1904-06. They have each occupied the same site since establishment.

Source of Crude Ores. The zinc ore is received from two sources, that of the Joplin, Missouri, field and that of the Wisconsin zinc field. It is zinc blende (sulphide of zinc). One analysis of the ore as received from the mines is here given:

Raw Ore—Received September 14, 1910:

61.19% Zinc.
31.12% sulphur.
1.61% iron.
.54% lime rock.
.45% lead.
3.80% silica.
1.29% undetermined (consisting mostly of manganese, magnesium, iron oxide.)
(Consisting mostly of manganese, magnesium, iron oxide.)

It is asserted that absolutely no trace of arsenic is demonstrable in the ore. The chief chemist of one of the concerns stated that the Federal Government stationed a chemist here two years ago who was unable to find a trace of arsenic in the ore at any time.

The Processes Concerned in Zinc Smelting. These are here stated very briefly. There are first the processes necessary to prepare the zinc blende for smelting. They are roasting, sizing and calcining. These are to drive off the excess of sulphur and to heighten the percentage composition of zinc. Sulphuric acid is an extensive by-product of these processes.

When the ore is finally ready for smelting in the great zinc retort furnaces, which are modifications of the Belgian process, an analysis shows the following composition:

The "Charge" (or Roasted Ore):

87.24% zinc oxide.
2.97% sulphur dioxide.
2.89% iron oxide.
.54% lead oxide.
1.26% calcium oxide.
4.20% silica.
The above is an average analysis.

Each zinc smelting furnace with its hundreds of retorts is charged once a day, usually by short-shift men who work from 5 to 11 a. m. The charge having the above composition resembles coarse sand of a terra cotta color. This is mixed with about equal parts of coal screenings. When ready to charge a retort the spout of the latter, which has been plastered on, is removed and this coal-zinc-ore mixture introduced into the retort by means of narrow scoop shovels which the workmen apply. As soon as charged the spouts are again plastered on the retorts. A few hours later the workmen approach the spouts of the retorts with long-handled iron ladles and a scraper, and remove from five to ten pounds of molten zinc covered with dross, which, after skimming, they pour into iron moulds. Thereafter, throughout the day and night, the men keep interruptedly scraping out the spouts to recover the sublimed zinc.

These zinc smelting furnaces employ about half of the total help of each plant. They are located in one-story foundry type buildings. Each furnace or "block" of retorts rises from the floor to eight feet high and covers an area of about sixteen by sixty square feet. Each block contains from 660 to 800 retorts, arranged usually in seven layers, one above another, so that the uppermost are just within reach of the furnacemen. Half of the total retorts in each furnace are located on each side of the furnace block. Fuel gas is used for heating purposes. Each furnace resembles a river barge or scow rigged up like a battleship with innumerable port-holes on each side, through which the muzzles or spouts of the retorts protrude. By this arrangement all of the retorts are entirely within the furnace and not visible from the outside. The spout is in reality a condenser projecting to the outside about one foot. From each such spout, zinc flames, with characteristic light smoke, are pouring in a continuous blaze, though without much force or blast. The smoke as it passes through the length of the spout has most of its zinc contents sublimed as metallic zinc. The smoke as it leaves the end of each spout rises upward and most of it passes beneath a broad hood or canopy which covers the entire furnace block and is connected with stacks above.

In two of the concerns these zinc slabs and ingots are many of them further submitted to rolling mill processes and supplied to the market in the form of large sheets. The chemist at one concern stated that brass founders found it necessary to buy a grade of zinc which was relatively very poor in lead content, usually less than 1%, although, in making brass, lead was often added later.

Employees. These varied from 150 to 800 in each establishment, or a total of about 2,000. About half are engaged around the zinc smelters. There are no women employees. There is, however, a small per cent of boys or youths employed. This help is Polish almost to a man. They are not unionized. They are not regarded as skilled labor, although a little experience is necessary to become a good furnaceman. They receive from $1.90 to $2 per day, some of them working in short-shifts of six to eight hours, some in long-shifts of twelve hours.

The Buildings. These zinc furnaces are located at two of the concerns simply upon the ground for a floor, while the third concern has

its smelters all raised above the ground about the height of a second story, with cement flooring. At one of these concerns each furnace block is in an individual building, which, however, is no more than a mere frame shell resembling a large barn with the sides and roof nearly all open. At a second concern all of the furnaces are within one large enclosure, which is also frame and covers an immense area, while over each furnace block is a Texas roof having a great many openings for ventilation. At the third concern the furnace blocks are arranged in long rows within two long narrow buildings constructed of steel and cement, the roofs of each building being of modern foundry type.

There were no buildings surrounding these in such a way as to interfere with natural ventilation, although the surrounding hillsides are somewhat of an interference.

In none of the concerns are there any other processes within the zinc furnace buildings than that of the smelting of the zinc.

The size of all these buildings was sufficient as regarded cubic feet of air space per man.

Ventilation. At two of these plants this was very good for the season of the year visited (the early fall). At the third, however, it was very poor. At all three concerns great doorways seemed largely depended upon for ventilation. Also the roofs in all cases were of as open a structure as could be considered compatible with inclement weather conditions. At one concern, artificial ventilation in the form of a very elaborate blower system was installed, which seemed to add very materially to the removal of the noxious zinc fumes from the vicinity of the workmen, and undoubtedly is efficient enough for all seasons of the year. I was informed by the superintendent of one of these concerns that it is necessary to close up these furnace rooms considerably in the winter-time in order to prevent chilling of the furnaces.

Light. This was found good in two of the concerns, poor in the third. It is of course worse in the winter-time because of the closing up of the openings.

Temperature. This was found to be almost intolerable at one concern in the vicinity where it was necessary for a great many workmen to be, and here it was found that the workmen were frequently using hose to cool down the sides of the furnaces and drive back the heat. At a second concern, which was more open, it was better, but still far from bearable for any length of time. At a third concern it was found fairly good, due principally to the establishment of artificial ventilation for controlling it. At all three concerns the workmen used huge iron shields which they moved up and down on small tracks or runways in front of the broadside of each furnace to protect them from the heat.

Cleanliness. In two plants this was found particularly poor, the floors being of dirt, with the dust several inches thick, and the walls, rafters and beams covered with smoke deposits. At the third concern, cleanliness was good. Apparently whitewashing was very seldom done.

Heat in Winter. In two of the concerns this was found to be unprovided for at all, while at the third the arrangements were not noted. The heat from the furnaces themselves is depended upon.

Regarding the height of roofs, these were about alike in all places, being about twelve to eighteen feet at the eaves and peaked upwards to twenty to thirty feet at the centers.

Roof ventilation was of the Texas type, that is, steeply pitched on both sides with long, central, latticed top extending higher.

Lunch Quarters. These were absent at all three concerns visited. The workmen usually bring lunches in dinner pails and eat in the furnace rooms or in whatever buildings they are employed. Their lunch pails were found sitting around the furnace rooms and smelting rooms, against posts or on boxes. The men were allowed half-hour noons, while at one plant they were also allowed two lunch periods of about fifteen minutes each in addition to the usual noon period. However, the smelters were not continuously engaged, so that they had opportunity to "take a bite" whenever they wished. The drinking water appeared to be a source of complaint at all three plants, both the officials and the working men blaming it for the occurrence of severe attacks of abdominal colic among the workmen during the summer-time, especially after long exposure to heat. However, the water was obtained from artesian wells at one place and from the company's private wells at the two other concerns and was the same as used by the inhabitants of the towns.

Wash-up Quarters were lacking altogether at all three places. There were faucets on pipes protruding through the floors in all the furnace and smelting rooms, from which the men secured water in pails, often set it alongside the smelters to warm it, and used it for washing purposes. At one plant I found the concern gave the men time to strip to the waist and to bathe from buckets before quitting time each day. This was not allowed at the other two concerns. The men themselves provided whatever soap and towels they used.

Toilet Arrangements. These were of the crudest sort at all three plants, consisting of temporary frame out-buildings without sewer connections, water or even seats in most instances. I was informed at one plant that they were re-constructed every couple of years at new sites.

The Employees. These were Polish almost without exception, many of them having followed the zinc-smelting trade in this country and even at the same plants for the past twenty-five to thirty years. In spite of this very few of them spoke English or appeared to understand it. On this account it was usually necessary to converse with them through interpreters. Many of the younger men were found to be sons of the older men. Most of the younger men could talk English. As in the brass foundries in Chicago, the vast majority of the men were under forty-five years of age.

Evidence of Trade Diseases. This was somewhat difficult to secure, both because so few men were found that could speak English or German, and probably because of fear from the presence of their officials, although the latter assisted very much in bringing out facts. The evidence secured from the workmen themselves, both in the presence of

officials and alone, from the officials, and from doctors in the neighboring towns, may be summed up as follows:

(1) As was the condition in the brass foundries in Chicago, neither officials nor doctors who attended the sick brass workers were familiar with the condition known as brassman's ague or the "chills," but, almost from the first man consulted, the existence of "zinc chills," "smelter shakes" or just "the shakes" was affirmed, the men here laying the cause to the breathing of the zinc smoke. However, zinc smelters were found not to be as subject to this form of trade sickness as brass moulders because they do not breathe the zinc smoke to the same extent nor are they as much exposed to it. Also, it being the prime object of the process to redeem all of the zinc possible from the metallic smoke, its concentration in volatile zinc is by no means as rich as that usually produced in brass foundries. There is also some malaria in the Illinois River valley at this point, but the doctors declared it very little prevalent and apparently disappearing altogether, while the workmen were certain they could tell the difference between the malarial "ague" and "smelter shakes." The latter, they declared, one would always get if he breathed the zinc fumes to any extent. The workmen attach very little importance to these zinc chills and rarely lay off on account of them.

(2) Both officials and doctors were cognizant of the presence of some lead-poisoning among the zinc workers, while the investigator found definite symptoms of lead-poisoning among several of the workmen at the different plants. The calciners seemed to be the most liable to such poisoning because they work where the crude ore is first roasted. Next to these came the lead-burners or the workmen who repair the enormous lead tanks used for the concentration of the sulphuric by-product. The last in order came the workmen around the zinc smelters, some of whom were found with symptoms of lead-poisoning. The roasted ore, as it goes into the smelters, as shown in the before-stated analysis, contains about the same per cent of lead as before it was calcined.

(3) A very prevalent condition found to exist was severe summer colics, alleged to be due to the drinking of ice-cold water when overheated. Nearly all of the workmen had suffered from these and many of them many times. This is a severe condition, causing the men to be off from work one to two weeks at a time, and is accompanied by obstinate constipation, many times by nausea and vomiting, and always by severe prostration and suffering. One doctor gave evidence of having been called to plants several times to give immediate relief to workmen suffering with this condition. Whether this is the expression of a seasonal form of lead colic, such as has been stated to exist abroad, or not, could not be determined. Apparently the nature of the industry is one of the factors concerned, since the men at the zinc furnaces seemed to be the only ones so attacked.

(4) Nearly all the older furnace men suffer from what they call "asthma" a great deal. It is a "chronic bronchitis," according to one of the doctors, and "undoubtedly a great deal of it ends in tuberculosis." It is far more prevalent in the winter-time, even the younger men being affected then, and it was found that not a few of the older men actually

laid off most of the winter because of this condition. They claimed that it was due to the breathing of the smoke and fumes, which were always more prevalent in the winter-time or in inclement weather.

(5) Alcoholism. This was found to exist to the same extent, if not greater, than among brass workers. The workmen consider alcoholic liquors antidotal to various forms of trade-sickness.

(6) Gas Poisoning. As all of the concerns make their own gas, which is used for fuel in the smelters, they have quite extensive gas plants. Officials, doctors and workmen spoke of the occasional accident of "gassing." Some of these cases resulted in fatality, although the large majority were only slightly affected as a rule and soon back at work again.

Names and personal statistics were secured of eight men who had suffered from zinc chills, six men who had suffered from lead-poisoning and four men who had suffered from colics. About sixty workmen were consulted altogether, but only the most pronounced cases were selected.

PART IV.

Summary of the Dangers of the Brass Industry, Hygienically Considered, with Recommendations as to Their Control.

In this industry the dangers, other than accidents, are:

In the Foundry, Refining, or Smelting Processes.

1. Inhalation of metallic vapors (zinc, copper, tin, lead, phosphorus, arsenic, antimony, and nickel).

2. Inhalation of carbon monoxide and other gases of incomplete combustion from furnaces.

3. Handling of lead in some processes in its pure state (refiners, resmelters, babbitt workers, journal-bearing liners), while lead is an alloyed constituent of practically all brass and bronze compositions, and indeed in all alloys of soft metals.

4. Effects of fatiguing labor. Workmen complain that they are now required to do from one-half to double again as much as they were wont to do ten to twenty years ago.

5. Women, girls and boys are more susceptible to poisoning from metallic vapors and dust than men.

In the Finishing Processes.

6. Inhalation of brass and other dusts (grinding, polishing, buffing, rubbing, skimming, turning, burnishing, boring, etc.).

7. Skin irritations from fine brass dust.

In the Plating Processes.

8. Inhalation of mineral acid vapors where castings are dipped into such acids for the purpose of cleaning them preparatory to plating. The acids commonly used are mixtures of sulphuric, nitric, and hydrochloric.

9. Inhalation of hot potash vapors (cleaning processes).

10. Inhalations from hot potassium cyanide solutions which are contained in large tanks or vats and are used as electrolytic solutions.

11. Shellac vapors are always very noticeable and are detrimental to health where wood alcohol or benzine are used as diluents or solvents.

12. Effects of dampness, standing on wet floors, placing hands and arms alternately in and out of water and various solutions.

In All Processes.

13. Eating in workshops often in the midst of smoke, vapors and dust.

14. Lack of personal cleanliness often due to inadequate washing facilities. Hence men handling metals eat and drink without washing hands, etc.

15. Toilets directly exposed to workshop atmosphere.

16. Lack of cleanliness in the foundry or workshop, dust and smoke deposits upon ceiling, rafters, walls, etc.

17. Thermal exposures either to excessive heat from furnaces or to exposures to cold in the winter.

18. Lunch periods too short for men to wash and eat. These were found to vary from fifteen to thirty minutes.

All of the above dangers can be grouped under two headings: The Manufacturer's Responsibility and the Employee's Responsibility.

(*a*) *The Manufacturer's Responsibility.*

In the Foundry, Refining, or Smelting Shop.

1. Metallic fumes. These arise from (A) the tops of furnaces where lids are not close fitting, from spouts of zinc smelting retorts, and from all oil furnaces because tops continuously emit the blasts containing metal fumes to the air of room. (B) On opening tops of furnaces to add more metal or fuel. (C) Upon removing crucibles containing melted brass or similar alloys from furnaces. (D) Upon the addition of zinc, lead, phosphorus, etc., to the pots of molten metal after they are removed from furnaces. (E) Upon the pouring of the metal into moulds. (F) While the metal is cooling in the moulds. (G) On opening the moulds. *Corrections advised.* (A) Provide all furnaces with proper hoods and stacks. (B) Provide a so-called apron around furnace area. (C) Separate furnace-room from balance of workshop. (D) Provide ceiling ventilators or skylights which must be made as effective in inclement weather as in fair weather. (E) Provide suction fans installed in ceiling or upper windows to remove such smoke in all places where melting and pouring is a more or less continuous process all day, or where vapors tend to hang about more than ten to fifteen minutes after a pouring. (F) Do not employ sickly or anemic workmen at such processes.

2. Carbon Monoxide Fumes. These arise from the furnaces particularly on starting up in the morning, and chief complaints are from oil-blast furnaces. Corrections the same as for metallic fumes.

3. Lead exists in all brass alloys from ¼% to 7%. It is present in all scrap metal (handled, sorted, melted), is often added to the molten copper, brass, etc., and is present in zinc ores. Usually only one man in a shop handles it where it is used in the shape of ingots to add to various alloys. In some brass foundries separate lead kettles are used, open topped, and thus certain men in brass foundry-work may become leaded. *Corrections:* These are no different than those which must be observed wherever lead exists as vapor, dust, in alloys, or has to be handled. In brief, sprinkle all scrap metal before handling or sorting it. Provide proper ventilation schemes as noted above for removing metallic vapors and dust. Respirators and gloves for all workmen exposed to lead in finely divided particles or as fumes. Women and boys should not be employed in such processes. Anemic or sickly persons should not be employed in such processes. Examinations monthly by a physician of all workmen so exposed, with the elimination of those who show signs of lead poisoning. The personal factor is a great one: some persons are extremely susceptible to lead and cannot endure exposure to it whatever.

4. Fatigue. There is considerable complaint among many brass moulders of the constant physical and mental strain required at the present day. A foreman or other expert sets a pace on a certain class of work for a few hours or a day's time, then men are compelled to keep up to this record daily. *Correction:* Limit the number of standard flasks or moulds or their equivalents which a man should be expected to turn out in a day.

5. Women are employed in some large establishments as core makers. They usually work in rooms inefficiently partitioned off from foundry quarters and are thus exposed to foundry vapors, smoke, and dust. In addition, some large firms employ women and young girls at polishing and buffing processes, a very questionable procedure. *Correction:* Women should be in rooms or on some floor outside the foundry, whence cores may be sent to the foundry.

In the Finishing Processes.

6. Polishing, Buffing and Similar Dusty Processes. The large majority of workmen are now protected from inhaling brass dust by the blowers or suction fans required by law. Still the law does not cover one-man processes; nor when grinding is done upon large metal castings are the workmen well enough protected, since they are compelled to remove the blowers, which are in the way, or none are provided at all. *Corrections:* All concerns employing one or more men at polishing, buffing, or grinding by dry processes for more than two hours a day should provide an efficient blower system to remove dust. When such processes are done upon large castings and especially with belts, traveling emery wheels, etc., a large hood with very powerful air-suction system should be provided and a regular inspection made to see that same is in good working order.

7. Irritating Dusts. This is largely a question of carelessness in personal cleanliness. At the most only a mild form of dermatitis develops. *Corrections:* Limit the amount of atmospheric dust by means above noted, and require workmen to bathe frequently.

8. Acid Fumes. These arise where castings are dipped into mixed mineral acids for the purpose of cleaning them preparatory to plating. The law requires hoods and stacks when such process is continuous. *Correction:* A hood and pipe to a window or stack and, when necessary, a suction fan for all pots or vats from which fumes arise.

9. Hot Potash Solutions. These stand usually in large vats. They cause a dryness of the throat and an irritating cough. *Corrections:* A low hung hood with connection to proper stack should be suspended over such vats.

10. Cyanide Solutions. The unstable character of all cyanide compounds causes them to slowly disentegrate and yield hydrocyanic acid which is volatile. Potassium cyanide is the compound used in plating and it is used extensively. It is also used hot and stands in large open-topped vats. *Correction:* A low hung hood with connections to proper stack should be suspended over such vats.

11. Shellac. The vapors from the solvent used (amyl-acetate, wood alcohol, benzine, etc.) cause irritation of the respiratory tract and often sicken the workmen. *Corrections:* These are difficult to suggest since certain solvents are necessary. Also drafts or air-currents are said to spoil the work. Probably only healthy men (not women) should be permitted to do this. Not so detrimental in simple brushing or dipping processes, but more so in spraying processes, for which some firms have a machine with special hood and stack provided.

12. Water and Dampness. In most plating rooms, quarters are very wet from splashing water and various solutions on the floor. *Corrections:* Limit the unnecessary splashing as much as possible. Provide elevated floor treads to stand and walk upon. Provide rapid drains to remove water from the floor. Provide rubber boots and perhaps rubber aprons for the workmen.

In All Processes.

13. Eating. Practically all shops allow half an hour for noons and workmen eat in the shops. *Corrections:* Should allow at least three-quarters of an hour to give time for washing up properly before eating. Should not allow workmen to eat in any foundry, smelting room, furnace room, polishing or buffing room, or any place where smoke, metal fumes, or metal dust pervades the atmosphere at any time of the day.

14. Washing Facilities. In practically all places no time is allowed for workmen to wash before eating or leaving the plant. Very often facilities are by far inadequate. No soap, hot water, towels; often no sink, basins, or even buckets provided. *Corrections:* Allow five or ten minutes' time for washing up before noon and at quitting time. Provide enough basins, buckets, or other wash places, hot water, soft soap, and coarse towels. Such arrangements should properly be outside the workroom. Shower-baths should be provided for use of all furnacemen,

smelters, and refiners. Those so far seen have been installed much cheaper than ordinary plumbing for wash bowls, etc.

15. Toilets. In many places these are crude affairs inefficiently partitioned off in the workshop itself. *Corrections:* Proper sanitary arrangements and in quarters entirely separate from workrooms.

16. Cleanliness. As metallic vapors and dust cause a thick deposit within a short time upon walls, ceilings, and all exposed surfaces, it is *recommended* that all foundries, smelting rooms, polishing and buffing quarters be cleaned down and whitewashed at least twice a year. Also the sprinkling of floors or the use of petroleum oils will lay the dust.

17. Winter Heating. In most foundries as they exist at present, there is great variation in temperature throughout the day because the men have to open the windows frequently for ventilation, which at the same time causes them to suffer from the cold. Within a short time they may all be suffering from the heat from furnaces or pouring also because ventilation is not adequate. In some places the heat from furnaces or salamanders is depended upon for maintaining workable room temperature. *Corrections:* Proper arrangements should be made to maintain an even temperature in the foundry (steam, hot water, or hot air) of at least 53° F., without exposing employees to noxious vapors from furnaces, stoves, or salamanders.

18. Short Lunch Periods. Workmen in this industry should be allowed at least forty-five minutes in order to wash up, leave workrooms, eat and return.

(*b*) *Employees' Responsibility for Exposure.*

Foundry Men. Many men needlessly and foolishly expose themselves to metallic vapors, gas fumes, handling of lead, etc. Corrections are obvious.

Eating Place. Workmen should not eat in foundry rooms, smelting room, polishing, buffing, or grinding departments, or any places exposed to metallic vapors, smoke, or where metallic dust of any kind may collect.

Personal Cleanliness. Workmen should wash hands, lips, and face well before eating. Even putting tobacco in the mouth allows dirt to be carried from the hands to the digestive tract. Dust on the moustache is swallowed with whatever food or drink is strained through the moustache. These workers should not wear moustaches, or should keep them cut very close. All smelters and furnace men should take a shower bath every day before leaving plant, at which time they should change from their workshop underwear and clothes to their civilian suits. (German workmen claim this is regularly done in Germany.)

When workmen notice the *effect of vapors or smoke* upon the throat, lungs, stomach, or head after leaving the workshop, they should by all means avoid the use of whiskey or other strong alcoholic drink. They are recommended to use, instead, hot milk, oatmeal water, and other such muciparous drinks, and to resort to mild purgatives, such as Epsom salts, castor oil, or calomel, in the evening, followed by salts in the morning.

There is no know specific for *Brass Founders' Ague.* Avoid brass fumes. Refuse to work in places where it is impossible to keep from breathing them. When the chill comes on, go to bed at once, cover up well, drink hot milk containing pepper, hot water or hot lemonade. Avoid absolutely the use of whiskey Take some one of the mild purgatives above mentioned.

All workmen who are employed about lead kettles, melting pots, or lead furnaces, or handle scrap metal, should wear gloves as far as practicable; should observe great care to wash hands, lips, and face thoroughly before eating or putting anything in the mouth. Such washing should be done with warm water and soap. They should wear continuously some form of respirator, they should not grow moustaches, they should see that the floors and the metals which they handle are kept sprinkled or oiled often enough to keep down all dust. Personally they should see that the bowels are kept regular, they should quit such work if they note that their general health is suffering in the least, or if they note the unwonted frequency of headache, constipation, abdominal colic or cramps, dizziness, poor appetite, loss of sleep, loss of weight or general indisposition.

2a The Effects of Turpentine Upon the Health of Workmen.

By R. H. Nicholl, T. E. Flinn, M.D., E. R. Hayhurst, M.D.

Among the trades in which turpentine is used extensively, and in such a way that its vapors may affect the health of the workman, is that of the painter's and varnisher's trade. It is where turpentine is used in closed room or confined quarters that the effect of its vapors becomes noticeable, hence it is that class of painters who work in paint shops, carriage, wagon and automobile shops who are most frequently affected.

That turpentine may under certain circumstances be a decided poison, we note the following quotations from a few eminent authorities:

H. C. Wood, Therapeutics, 1905: "Turpentine is a powerful irritant, causing in a very short time inflammation in any tissue with which it comes in contact."

Peterson & Haines, Legal Medicine and Toxicology, 1904: "Severe poisoning may result from the long-continued inhalation of vapors of turpentine, as by painters or varnishers or by those who sleep in freshly varnished rooms. The symptoms are headache, dizziness, bronchitis, and often irritation of the *kidneys.* Tolerance is readily established. . . . Various forms of skin eruptions have been described."

George M. Kober, of the President's Home Commission, in his book "Industrial and Personal Hygiene," 1908: "Turpentine vapors in excess may produce gastric and pulmonary catarrh, slow and painful micturition (urination) and bloody urine, headache, roaring in the ears, and other nervous symptoms. Schuler observed among the workers in calico-printing marked emaciation, loss of appetite, rapid pulse, and more or less headache, which he attributed to the turpentine vapors. . . . The odor of violets in the urine is one of its remarkable effects. The use of impure turpentine for cleaning purposes has been known to produce obstinate eczema of the hands."

In order to determine to what extent painters and varnishers may have been afflicted with turpentine vapors in Chicago, observations were taken upon a total of 62 men. Many of these men were seen at their work places and the condition of their shops noted. Others were consulted at their union meetings. An endeavor was made to pick out the older workmen only and to rule out as far as possible all cases of lead poisoning. It may be said that nearly all of these men claim to have suffered more or less frequently the effects of turpentine vapor, such as those stated above, and especially to have noticed the effects upon the urinary system later. These latter were stated to be a desire to urinate frequently, with the passage of only small amounts of urine, oftentimes with much pain and burning sensation, attended with high discoloration of the urine, perhaps bloody urine, and the odor of violets. There was often also complaint of pain in the flanks and back. These urinary symptoms usually came on after the symptoms of drowsiness, headache, nausea, loss of appetite and sometimes vomiting, and dizziness, noticed while inhaling the vapors. Many workmen also blamed certain so-called varnish removers for the production of temporary ill-health.

The *age* of the painters consulted varied from 24 to 64 years. They may be grouped by ages as follows:

From 20 to 30 years of age	14 men
From 31 to 40 years of age	20 men
From 41 to 45 years of age	11 men
From 45 to 50 years of age	8 men
Over 51 years of age	9 men

Of the latter, two were over 60 years of age.

Nationalities:

Americans	24 men
Germans	14 men
Irish	2 men
Scandinavians	22 men
Total	62 men

Of the foreign-born workmen, the newest arrival had been here eight years, out of the first 30 men consulted. However, the last 32 consulted were largely Scandinavians, and several were of more recent arrival.

Grouped according to the number of years in which they had followed the painter's trade, we have:

Under 2 years	2 men
From 5 to 10 years	13 men
From 11 to 15 years	6 men
From 16 to 20 years	13 men
From 21 to 25 years	8 men
From 26 to 30 years	7 men
From 31 to 35 years	7 men
Over 36 years	6 men

The oldest workman was 64 years of age, and he was also longest at the trade—48 years.

At first an attempt was made to determine what particular part the workman performed in the painter's trade, such as varnisher, striper, etc.; but it was soon found impossible to follow such a classification, as all were engaged in every process some of the time.

Places of Work. An endeavor was made to get indoor painters only, with the result that practically all of the 62 men consulted had spent most of their time at indoor painting.

Of the 62 men consulted, 59 were members of various painters' unions.

Habits as to Alcoholism. Only 30 men were consulted upon this point. Of these, 22 admitted drinking moderately of alcoholic liquors, none excessively, while 8 claimed to be total abstainers.

Dates of Sickness. An endeavor was made to determine just when the effects of turpentine vapor were severe enough to produce urinary manifestations. Many of the older men dated this back from 10 to 15 years, while nearly all claimed that the constant recurrence of these effects were common. Of the total number of men consulted, 18 had had bladder and kidney trouble severe enough to require the services of a physician.

The Character of the Symptoms. Of the 62 men, the following classes of complaints were made:

Urinary disturbances	54 cases
Inflammation of the eye	21 cases
Respiratory symptoms	14 cases
Skin irritations	7 cases

In some, genital irritations, pronounced nervous manifestations, and occasionally rheumatism were laid to turpentine vapors, although with doubtful relationship.

Results of Urinary Analyses. From the total of 62 men, 44 submitted specimens of urine for chemical and microscopical analysis. Of these 44 specimens, 14 showed evidences of organic kidney disease, based upon the following findings:

Four showed both albumen and casts, 8 showed a considerable number of casts only (the forms which are usually associated with chronic kidney disease), and 2 showed a considerable amount of albumen without casts or pus cells.

The ages of the 14 men whose samples showed evidence of chronic urinary disease:

Below 40	3 men
From 40 to 50 years	5 men
From 50 to 60 years	6 men

The lengths of time at which these 14 men had been at the painter's trade were:

Below 15 years	1 man
From 15 to 25 years	5 men
From 25 to 40 years	8 men

From the above it will be noted that the older men are especially those who showed organic urinary disturbances, their relative numbers being almost in direct ratio to their years of age and to their years spent at the trade. Of course, it is impossible to ascertain the exact extent to which turpentine vapors have been responsible for this large percentage of organic urinary disease, but only 3 of the 44 men whose urines were examined gave evidence of ever having had lead poisoning, the next most probable cause, as diagnosed by their physicians in the past. Inasmuch as acute urinary disturbances are so frequently complained of by these workmen after an exposure to the vapors of turpentine, it is reasonable to suppose that the latter are in a large measure responsible for the ultimate chronic disease which develops. It is known only too well that any case of chronic kidney disease may at any time suddenly develop acute symptoms of uremia, which so frequently ends in death.

Time Lost by the Workmen. According to the statements made by the workmen, the 62 men had lost a total of 1,098 days, representing about $5,200, due to sickness from temporary effects, or actual acute Bright's disease following the inhalation of turpentine vapors.

Benefits Received. According to the workmen, 5 of the 62 consulted had received a total of $236 from their unions. None had received compensation from their employers. Nine had sought charitable relief from various dispensaries and hospitals.

The Effects on the Eyes. The temporary congestion of the conjunctiva caused by turpentine vapors may end in actual inflammation, which usually subsides, but may persist as a chronic condition. The frequency with which one notes the appearance of red and inflamed eyes in painters is evidence of this.

The Effect on the Respiratory System. Of the 62 men consulted, 14 complained of the irritative effects of turpentine vapors upon the respiratory system, often causing severe coughing while inhaling the vapors. This was said to cease as soon as the workman got into the open air, but it must be regarded as a factor in the production of chronic bronchitis among painters.

The Effects upon the Skin. Many painters complained especially of the effects of turpentine and certain varnish removers upon the skin. Of 18 physicians' certificates turned into one painters' union within a

period of 4 months, 4 of them were for treatments of dermatitis (inflammation of the skin), which the painters' officials claimed were due to the above causes.

Summary. From a study of the above tabulated cases it seems fair to conclude that (1) turpentine vapor is readily absorbed in toxic amounts into the human system; (2) that its vapors are a very frequent cause of conjunctivitis; (3) that it frequently causes severe inflammation of the skin; and (4) that its elimination by way of the kidneys is a common cause of the great frequency of acute and chronic urinary diseases among painters. The principal factor in this delcterious effect of turpentine vapor is the workman's exposure to it in a closely confined room or in a poorly ventilated workshop. In addition, there are various substitutes for turpentine, and inferior grades of turpentine, rapid dryers, varnish solvents, and varnish removers, which are undoubtedly more harmful than pure turpentine. Better ventilation and inspection of ingredients are the obvious corrections.

3. A Report of Investigations on Carbon Monoxide Poisoning carried out by Dr. Matthew Karasek and Dr. George L. Apfelbach, under the direction of Dr. Walter S. Haines.

Carbon monoxide (CO) is well known as a powerful poison; 0.05 per cent present in the atmosphere renders the latter actively dangerous, and even 0.02 per cent may cause severe symptoms. Several fatal cases of poisoning from the gas are reported annually. The gas is generated in great quantities in a large number of industries, and an investigation of its effects upon the workmen exposed to it seemed desirable.

Owing to the enormous amounts of the gas produced in the steel industry, and owing still further to the large number of men employed in this trade, we directed our investigation particularly to this line.

In this state there are five extensive steel plants, namely, Illinois Steel Company, South Chicago; Iroquois Steel Company, South Chicago; Illinois Steel Company, Joliet; Wisconsin Steel Company, South Chicago; and Federal Steel and Iron Company, South Chicago; in which collectively nearly 20,000 men are employed, when running full capacity. All of these have been carefully inspected, and also the large works at Gary, Ind., and those at East Chicago, Ind., for comparison.

The gas is produced during the smelting of the iron ore with coke and lime. Formerly it was a waste gas and allowed to escape into the air, but now all the products of combustion at the furnace top are collected and used for the heating of boilers, etc., and for the driving of gas engines.

There is also in common use in the steel and numerous other industries a special furnace in which coal generates a gas used mostly for heating. This is known as "producer gas." The following gives the average compositions of these gases:

Average Percentages—

	Blast Gas.	Producer Gas.
CO	26	23
CO_2	11-12	8
H	3.5	11
C_2H_4		0.7
CH_4	1.0	0.2
N	57.3	57.1
O	0.2	Trace

Whenever a worker is exposed sufficiently to blast or producer gas, there occurs an intoxication technically known as "gassing," with symptoms somewhat resembling ether narcosis. Fatal cases are not very common owing to prompt removal to fresh air, but accidents such as wounds and bruises are not infrequent by reason of unconsciousness and subsequent fall from a height or into machinery; naturally burns are very common under these conditions.

Our investigation however chiefly concerned itself in determining the effect of frequent or constant exposure to smaller amounts of the gas.

We critically examined 240 workers in the various steel works, who were frequently exposed to the gas, and found that very few of them were in good physical condition, but it is extremely difficult to state how much of this is due to carbon monoxide and how much to alcoholic and other excesses, unhygienic living, venereal diseases, etc. Obviously many of the conditions we noted, such as skin diseases, were in no way connected with CO; but one constant and suggestive feature presented itself. This was a deficient muscular power, as indicated by the hand dynamometer.

A comparison of the muscular strength of the hand gave the following results in 400 cases, selected as strictly comparable—crippled, diseased or those otherwise unsuitable, being left out.

Ages 20-40—Steel company workers, South Chicago, exposed to CO, average strength, 117.13.

Ages 20-40—Car company workers not exposed to CO, general hygiene, etc., good, average strength, 146.11.

Ages 20-40—Workers in three companies not exposed to CO, general hygiene ordinary, average strength, 134.43.

Ages over 40—Steel company workers as above, average strength, 94.30.

Ages over 40—Group II as above, average strength, 127.25.

Ages over 40—Group III as above, average strength, 113.01.

In the steel works at Joliet only 19 cases could be used for comparison, and we deemed this insufficient for any deductions.

We made blood examinations of 68 steel workers and found that in practically all those exposed to blast gas there was an increase in the number of red corpuscles, a condition technically known as polycythemia. The counts ran between 5,500,000 and 9,600,000 per cu. mm., two-thirds of them being over 6,000,000. No embryonal or other unusual forms of red cells were present. Seemingly this is a conservative action on the part of the system whereby the harmful effects of the gas are mitigated and greater toleration is established.

In 22 differential blood counts, 6 showed an increase of the eosinophiles, varying from 20 to 100 per cent above normal.

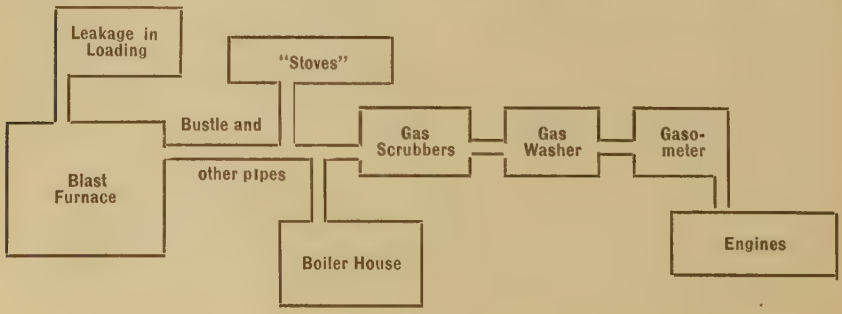
Further investigation concerning these blood changes and their significance is desirable; and it is important to determine whether the loss of power above noted is due to carbon monoxide. If such should prove to be the case, it means a large economic loss in the numerous industries where workers are exposed to CO.

The majority of the men examined seemed below the average mentally, but 97 per cent of them stated that they used alcoholic liquors, while 70 per cent admitted using alcohol in excessive quantities, consequently it becomes very difficult to make deductions as to the exact part played by CO. Since it is a well known fact, however, that prolonged exposure to carbon monoxide may produce a profound impression on the nervous system, we regard it as by no means improbable that a part of the sluggish mentality observed among the steel workers may be due to frequent exposure to the gas. Further investigation along this line is to be strongly recommended.

Insanities and psychoses of an incurable type have been reported as consequent upon prolonged exposure to CO. During our investigation we found three cases among the steel workers of intractable mental trouble produced, without the slightest doubt, by severe "gassing"; while a fourth man, after a long exposure to the gas, was mentally unsound for several days, but eventually recovered. Such cases, however, are relatively rare.

Places Where "Gassing" Occurs.

"Gassing" occurs with greater or less frequency all along the route of the gas. Thus, it originates in the blast furnace; part of it escapes at the top during loading of the furnace, and by leakage both above and



through the walls of the furnace. From the top, the gas is led by tubes or pipes (bustle pipes) around the furnace; to the boiler house for fuel; to the "gas scrubbers" and "gas washers" for separating undesirable materials; to the gasometers for temporary storage; and to the gas engines for motive power. "Gassing" also occurs during manual cleaning of the inside of any portion of this system, apparently from CO retained within the deposits on the sides and has occurred repeatedly when gas mains have been shut off by bulkheads for repairs or changes as no ordinary structure of brick or clay will stop the CO from passing through.

The tops of furnaces are notoriously dangerous, but since the establishment of automatic top feeders the number of men at the top at any time is reduced to a minimum of:—oilers present for about 20 minutes each 12 hours; "cleaners" (or "sweepers") to sweep up accumulations from the dumping cart, working from half an hour to several hours, according to the frequency of cleaning; "sailors" (or "riggers"), who are repair men employed while the furnace is in operation only for urgent repairs.

The "mantle" above the bustle pipes is nearly as dangerous as the top. It seems impossible to prevent leakage of gas through the walls of the furnace generally in a belt around the furnace about 12 feet from the ground, at the "mantle," very often in sufficient quantity to maintain continuous combustion when once ignited. This gas, if unignited, generally affects those on the casting floor.

The great danger about the "stoves" is at the enormous burners from adverse draft or puff-back of unconsumed gas and from leakage. A special danger exists during the cleaning out of a "stove" through one opening while gas is burning at the other. Explosions occur and the men suffer from burns.

In the boiler house the same danger of puff-back is present except in the later make of boilers which have the entering flue-burners sealed into the brick work, and receive air from a point about two feet below. This type of boiler we saw only in the Illinois Steel Company's alternating current boiler house. With this kind of burner an explosion may occur if the gas is carelessly turned on too rapidly at first. During our investigations we noted many flue-burners with large leaks and rents, either discharging the gas under pressure into the boiler room, or plugged indifferently with clay stoppers. Cleaning out the boilers frequently gives rise to "gassing" both in the removal of debris ("cinders") from the fire box and spaces, and of scale, etc., from the boiler drums. In spite of the fact that the fires are stopped and the draft-doors opened, thus allowing free air circulation, the men are gassed, probably from CO retained in the deposits.

In the gas cleaning apparatus serious and frequent cases have occurred at large works in Cleveland, Ohio, and we found one case recently at South Chicago, of an employé in the gas cleaning house gassed while seated in a chair.

Near the engines using blast gas instead of steam, danger lurks from leakages. Only recently an engineer in a steel works was found dead after falling asleep on the bed of the engine. The coroner's verdict was CO poisoning.

To illustrate the dangers of cleaning bustle pipes and flues, we cite the gassing of 24 men in one plant on October 15, 1910, while so engaged.

At the time of our investigations the steel mills were running half their full capacity or less. Of 10,000 steel workers 1178 were employed in the following departments. The appended figures illustrate our findings among these workers:

	No. of Men employed	Fatal cases	Severe cases per year	Mild cases per year	Sequellæ
Blast furnaces	900	13 during past 4 years	65	216	3 permanent psychoses
Boiler Houses	212		1	55 estimated from findings	
Gas engine	42	1 in 1910	4	variable	
Open hearths	24	—	1	variable	

The above were cases actually found. The real number occurring would be much higher, since mild cases are never recorded and are often forgotten.

On October 15, 1910, 28 men were gassed at one time requiring hospital attention. This occurred while cleaning a gas main.

Present Methods for Prevention and Treatment.

We find that in the past decade or two a very marked decrease in the number gassed in steel mills has occurred. This is due to the establishment of closed top, double bell blast furnaces; automatic top charging; thicker furnace walls with double instead of single riveted plates; conduction of gases in overhead mains instead of underground; the doing away with "pits" where deadly gases were apt to collect; systematic rules allowing no one above without special order; oxygen helmets for the most hazardous places; the education of the employés to the dangers by verbal or printed instructions; and other general improvements during the past few years.

The Illinois Steel Company has a hospital within the grounds at South Chicago where prompt and efficient attention is immediately available. Other works have emergency dispensaries. Instructions as to what to do are given in some plants. Oxygen tanks are available and used in two of the steel works with very good results.

On the following pages are shown copies of signs used in one steel company to warn employees and others against dangers from blast gas:

1. Posted at stairways leading to top of blast furnaces.

2. Posted at ladder and stairways leading above floor of furnaces.

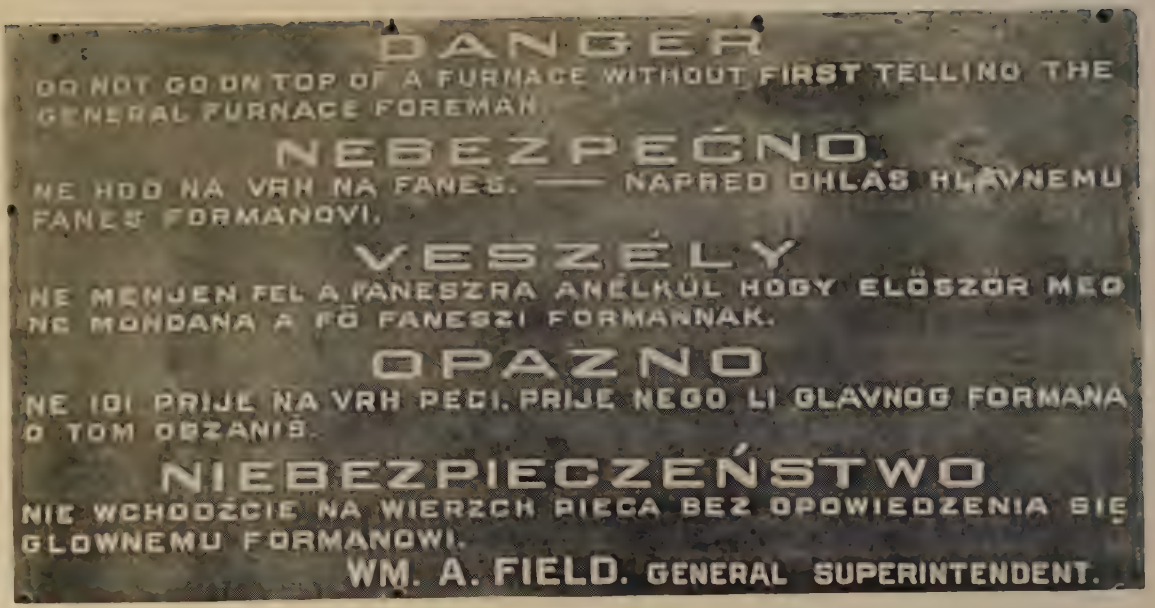
3. Posted in engine house basements, etc.

4. Posted around gas engines, pipes and gas mains in basement.

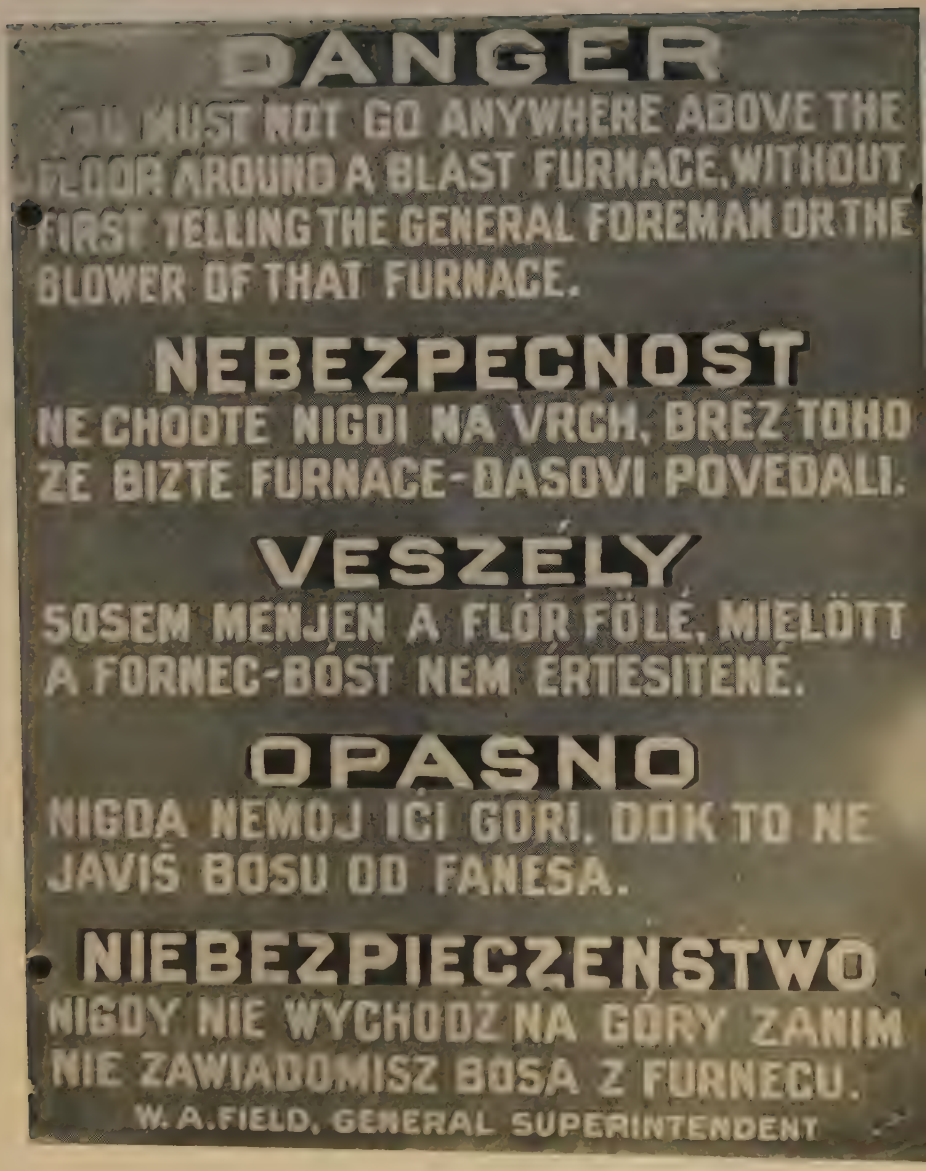
5. Posted in out of the way places, enclosed spaces about furnaces, engine-rooms, etc.

6. Posted at blast furnace plant to warn strangers.

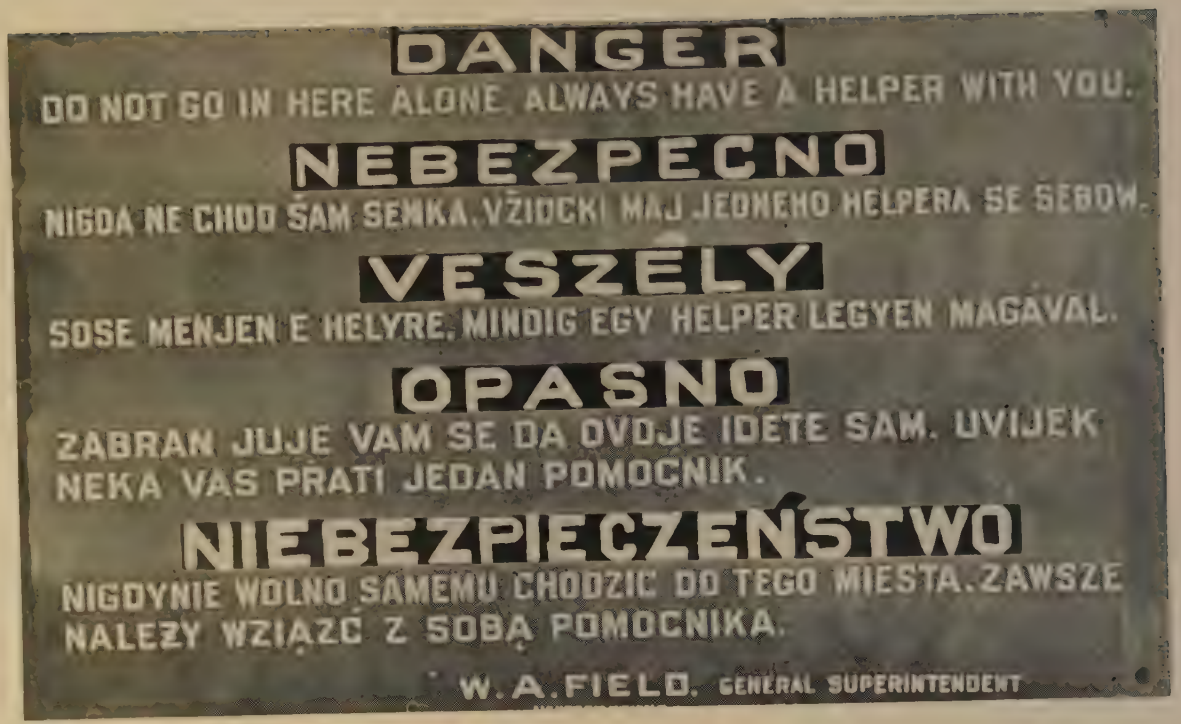
7. Posted in boiler houses.



No. 1. Posted at Stairways leading to Top of Blast Furnaces.

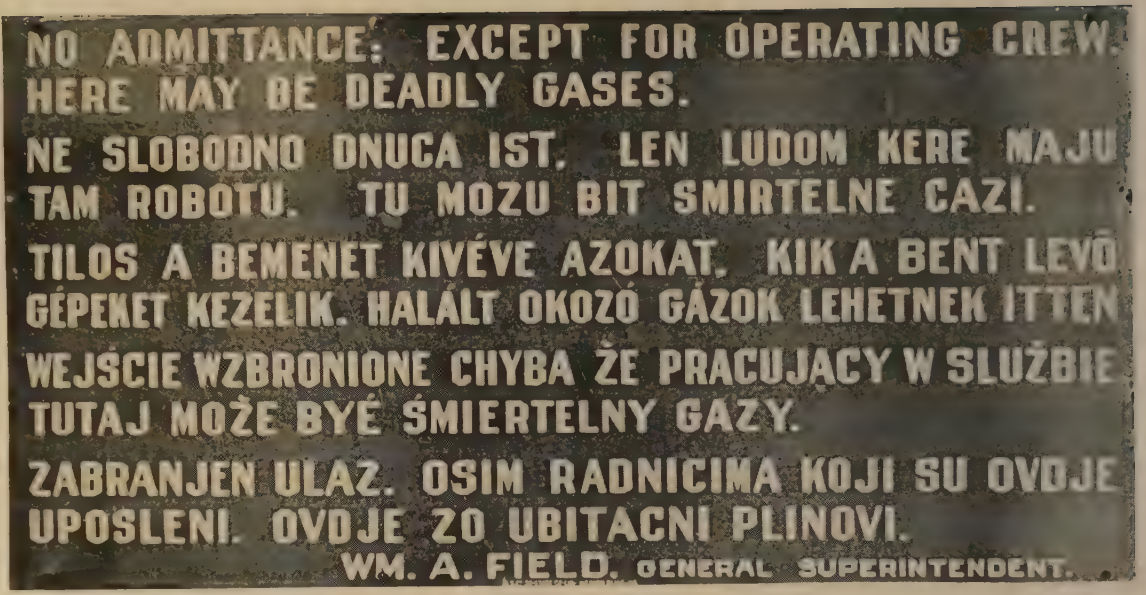


No. 2. Posted at Ladder and Stairways leading above Floor of Furnaces.

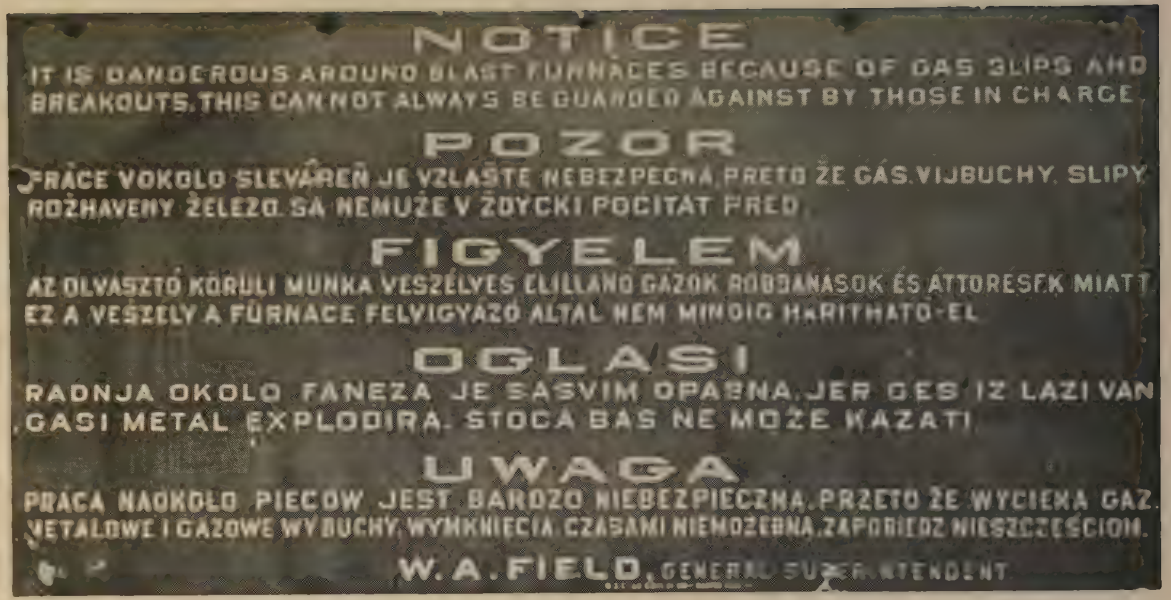


No. 3. Posted in Engine House Basements, etc.

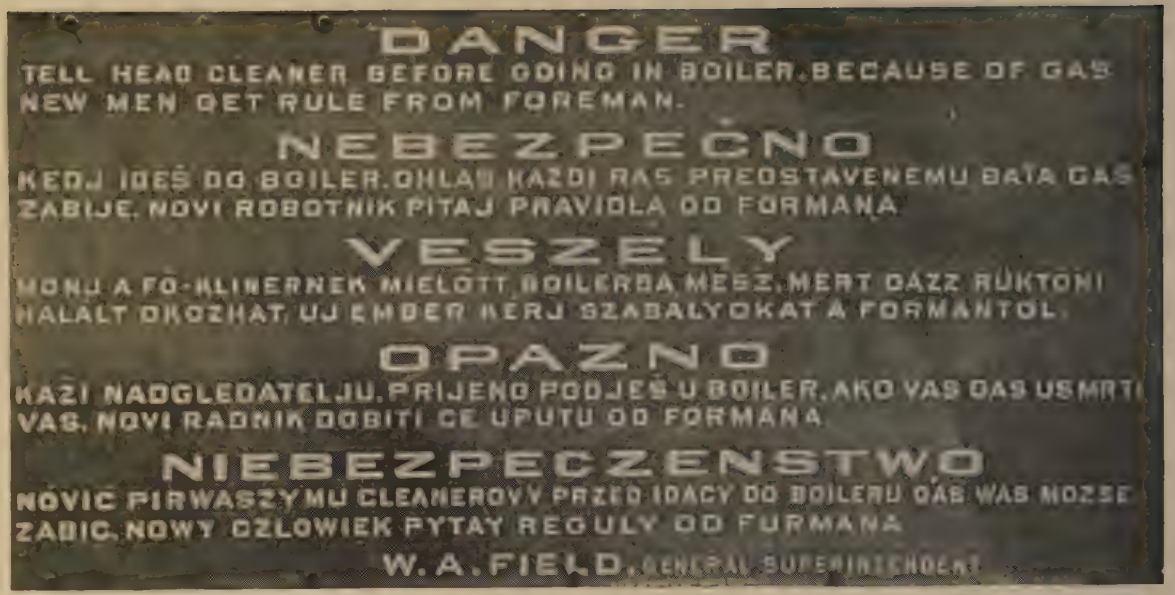
No. 4. Posted around Gas Engines, Pipes and Gas Mains in Basement.



No. 5. Posted in Out of the Way Places, Enclosed Spaces about Furnaces, Engine-rooms, etc.



No. 6. Posted at Blast Furnace Plant to Warn Strangers.



No. 7. Posted in Boiler Houses

Recommendations.

In view of the fact that leakages are bound to occur, we would suggest:

Provision for prompt medical attention such as an emergency dispensary within the grounds in all plants; physician or physicians constantly present or immediately available.

Maintenance of readily accessible tanks of oxygen.

Oxygen helmets for emergency work, such as rescuing unconscious workers.

Placards of instruction for first aid.

In order to decrease the numbers "gassed" we would urge:

Obligatory introduction of modern construction. The Illinois Steel Company has shown commendable promptness in this matter.

Systematic record and observation of the movements of those in places known to be highly dangerous from the presence of CO, so that those overcome may be promptly rescued.

Thorough instruction of employés regarding the dangers, with placards in various languages.

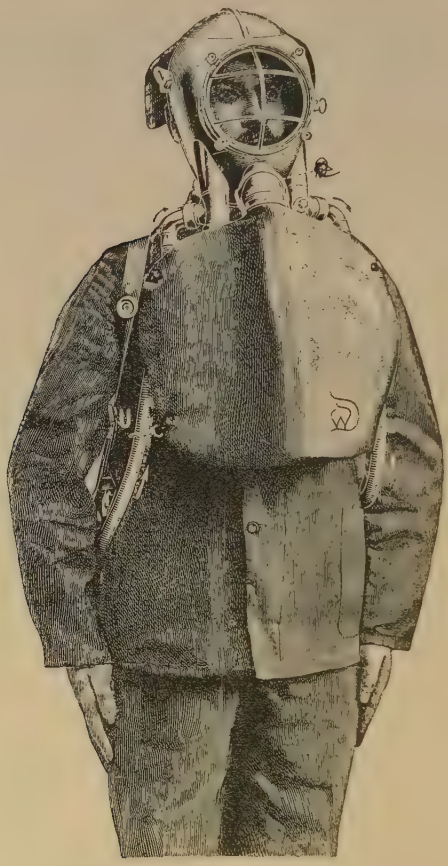
Prompt repairs of leaky parts.

Free ventilation where not present. One steel company has altered the roof of their boiler house since our investigation began, with marked decrease in the number of cases.

Refusal to employ around blast furnaces men who are at all under the influence of liquor, since such men are readily narcotized, not apprehending the danger to drowsiness. Such men occasionally sneak away to warm but dangerous places to sleep, and there fall victims to CO poisoning. For the purpose of decreasing indirect injury from CO, we believe that railings and guards are desirable to prevent men, while unconscious, from falling from a height or into dangerous machinery. Of 22 men acutely gassed and immediately rescued, 3 showed notable burns and 3 showed bruises, demonstrating that they were deeply and rapidly narcotized. We cite the case of one worker who was burned almost to a crisp before being taken out, and of another who fell to his death twenty-five feet below. Many other illustrations like these could be given.

Abundant experience has shown repeatedly that it is impossible for a man to enter a gaseous atmosphere, unaided by special apparatus, to rescue another overcome by the gas. Rare exceptions occur. Oxygen helmets make it possible to work continuously in a deadly atmosphere.

The following two cuts show such a contrivance furnishing fresh air to the wearer. No doubt many other helmets of similar sort are on the market.



FRONT VIEW OF APPARATUS.

CO Poisoning in the Illuminating Gas Industry

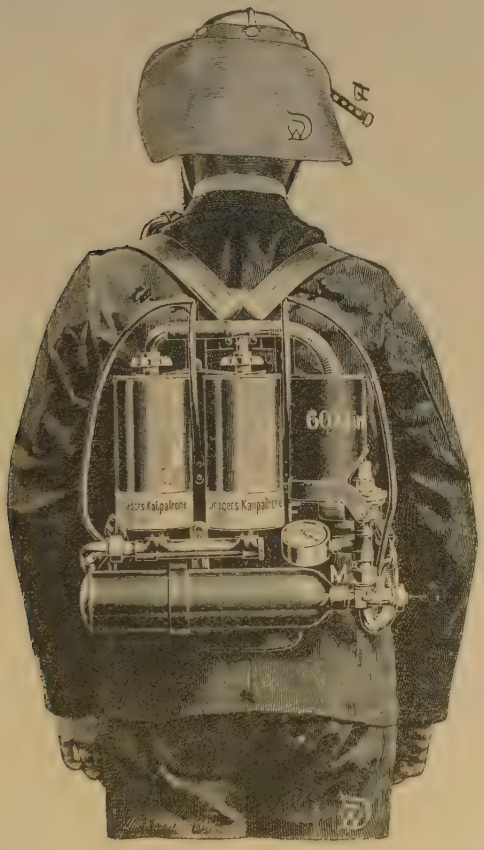
Lack of time made our investigation on poisoning by CO in the illuminating gas industry brief and incomplete.

A large illuminating gas company in this city has 6 manufacturing stations giving work to a total of about 700 men. About 1,000 other workers are distributed throughout Chicago putting in new mains, repairing leaks, etc. The total number employed, however, fluctuates, as it obviously must, and generally lies between 1,500 and 2,200 men. These men are exposed while at work not only to acute "gassing" but also to more or less continuous inhalation of small quantities of the gas, especially the underground workers in mains and conduits.

The average approximate composition of illuminating gas is:

CO_2	3.5%
CO	28.0%
Light oils	12.0%
Hydrogen	38.0%
Methane	18.0%
Oxygen	1.0%
	100.5

Its effects are principally due to CO and the findings in the few cases carefully studied, were like those resulting from blast gas. Six blood examinations on cases of recent gassing showed a like increase in the number of red blood corpuscles.



RESCUE APPARATUS, COMPLETE WITH SMOKE HELMET AND SINGLE CYLINDER.

We had no means in the limited time available to determine the exact frequency of gassing, but judge that since the company has issued posters showing how to treat those overcome, it occurs often enough to deserve further investigation.

Incidentally to our work, we have noted many things which, to us, as physicians, appear worthy of investigation, for probable injurious effects on workers; such investigation might lead to a prolonging of life and to economic gain. Among these may be mentioned.

1. Escape of products of combusion into the general work-room from gas, gasoline, coke, crude oil, etc.

   Of 6 tailor shops visited at South Chicago, every one practiced this.

   Coke for heating iron, used at a tack company, at a car company, etc.

.2 Dust of iron, lime, coal or glass, as in a tack company, a car company, a steel company, etc.

3. Use of fusel oil in certain industries, lacquering, etc.

4. Use in various industries of acids such as sulphuric and hydrochloric acids. Heated wire coils are dipped into these to remove scale, and give rise to strong acid fumes and perhaps to arsine, etc. Nitric acid and hydrochloric acid are used to remove oxides preparatory to electroplating.

5. "Sixty per cent of photo-engravers die of pulmonary tuberculosis." (President of their union.)

   Questions of ventilation and light.

Preliminary Report on the Injurious Effects of Metol, Platinum, Chromates, Cyanides, Hydrofluoric Acid and of Materials used in Silvering Mirrors

By Mrs. Stella R. Karasek and Dr. Matthew Karasek.

The Use of Metol in Photography.

Metol is used in nearly every studio visited except where discontinued because of evil effects. Chicago alone has 350 studios, and in investigating the injurious effects of chemicals in photography, 31 cases of metol poisoning were found in the 40 studios visited.

In all these cases metol produced an eruption, most often on the hands; in perhaps half the cases affecting the arms to the shoulder; and in some cases producing a rash over the body. The rash in the majority of cases lasted a few days and subsided; in other cases ulcers and running sores resulted, which healed with great difficulty, occasionally lasting for many months. A recurrence promptly followed other exposures to metol.

Rubber gloves prevent metol poisoning and do not interfere with any process in photography, but only two individuals were found during the entire investigation who made use of this simple preven tive.

The Use of Platinum Paper.

In these same 40 studios there were found 8 cases of deleterious effects from platinum paper, although many of the photographers had long since discontinued its use. The effects are: pronounced irritation of the throat and nasal passages, causing violent sneezing and coughing; bronchial irritation, causing such respiratory difficulties as to preclude the use of the paper entirely for some individuals; and irritation, upon contact with the skin, causing cracking, bleeding and pain.

The Use of Bichromate and Chromic Acid in Photo-Engraving.

These are used in an emulsion on copper-plates preparatory to receiving the negative. The well-known chrome ulcers result wherever these chemicals, especially the latter-mentioned, remain in contact with the skin for even a very short time. Occasionally an obstinate eczema supersedes the ulcers and recurs spontaneously after long periods. Only two severe cases were noted, but nearly all the photo-engravers mentioned numerous cases, generally of mild or moderate severity.

The Use of Cyanides by Photo-Engravers.

Potassium cyanide is a deadly poison whose acute effects are known to all. Its chronic effects manifest themselves in these workers by nausea, loss of appetite, headache, and a general disinclination to work. Until two years ago there was an average of 7-12 cases of cyanide poisoning reported annually to the secretary of the union, but during the past two years not a single case has been reported. This is due to the fact that one man does not do the cyanide work for six or more photographers, as was heretofore the case. Formerly, in many cases, the workers with cyanides were able to do this work only a short time, perhaps six to seven weeks, before having an acute attack of cyanide poisoning. In a few cases 24 hours of work was sufficient to produce acute poisoning. In all such cases a resumption of work with cyanides brought on another attack within two weeks, which generally ended fatally.

Potassium cyanide is used in the process of developing of negatives known as the "fixing" or "cutting." Most often this is done in the "operating" room, but in some places it is done in the "dark room" where ventilation is not good and it is here that workers more often notice the ill effects. It was surprising to find that the "dark room" in many places was simply a portion of the main room with partitions extending

to within about 14 inches of the ceiling, and open above, allowing the fumes from the "dark room" to mingle with the air of the general work room; also, to find that most of these places had no provision for ventilation except the outer windows, which were usually closed.

Mr. R. I. G——, an employé, wrote us: "The greatest boon we could get would be ventilated workrooms."

The following conditions were found and should receive attention: In most places the workers are permitted to eat their lunches in the workrooms. No gloves are used and there are no posters, instructions or warnings to employés regarding poisonous and dangerous chemicals; neither were labels present on any of the bottles containing potassium cyanide or other chemicals used in the rooms.

Silvering Mirrors.

Only one plant was visited and in this we found: 3 deaths during the last decade or so, supposedly due to working at this occupation. Four cases of constitutional evil effects due to this work and manifesting themselves as, rapid progressive loss of weight; continuous headaches; a disinclination to work, with a sense of muscular pain and weakness; a marked anemia; and a craving for stimulants to overcome the feeling of illness.

The men are unable to work at silvering for more than a few months before becoming completely disabled. The causative factor of this illness has not yet been determined, as time did not allow.

Hydrofluoric Acid in Etching of Glass.

Because of the very short time available only two days were spent in investigating this subject and only one place was visited. The fumes arising constantly, give rise to severe irritation of nasal passages, pharynx and bronchi and even of the lung tissue; to redness and marked swelling of the eyelids. If the acid solution is splashed upon the skin it corrodes the tissues like other caustic acids, leaving a slow healing ulcer. The post mortem findings on one case said to have died from the effects were fibroid lung tissue from repeated ulceration and scarring, and small ulcers and abscesses at the bifurcation of the bronchi. A medical examination of a worker exposed to the fumes showed bronchitis, also redness and swelling of the eyelids.

Gloves are used, but no protection for the eyes is afforded; neither are any forms of respirators employed.

We would strongly urge the use of goggles made throughout of celluloid, and the provision of hoods with strong forced ventilation.

Report on Compressed Air Disease, by Peter Bassoe, M. D.

CONTENTS

I. Introduction.

Work in compressed air in the state has been done chiefly in connection with the construction of (1) tunnels for water, sewers, and the freight tunnels in Chicago, (2) bridges, mainly railway bridges, (3) buildings (rarely). The investigation to be related has been made chiefly in connection with the first two kinds of work. Divers also are subject to compressed air disease, but as diving as an occupation plays an insignificant role in this state, it has not been especially studied.

The purpose of the compressed air is to keep water out and to prevent caving in while the work is in construction. The methods by which air is introduced and men and material can pass in and out are shown in

Fig. 1. A more complicated type of caisson, with separate locks for men and material, is seen in Fig. 2.

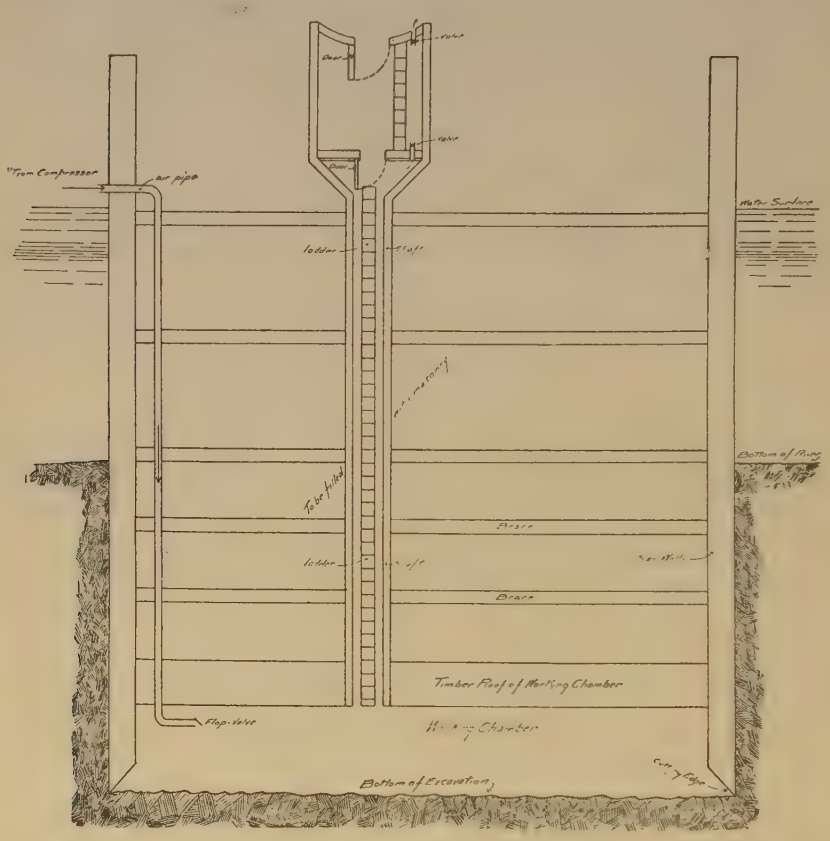


FIG. 1

Cross-Section Caisson under Construction for C. & N.-W. Ry. Bridge, Chicago. (*From article by Dr. J. E. Owens. The Railway Surgical Journal, March 1908*)

To Enter Caisson—Bottom door of lock is closed. Men enter from top door and close it; then top valve being closed, bottom valve is opened, thus equalizing pressure. Bottom door is then opened and men go down ladder to working chamber.

To Leave Caisson.—Top door of lock is closed. Men come up ladder and enter lock through bottom door, and close it. Then bottom valve being closed, top valve is opened, thus equalizing pressure. Top door is then opened, and men climb out of lock into open air.

II.

Essential Facts and Theories Regarding the Effects of Compressed Air on Man.

In a paper read before the Chicago Medical Society on Jan. 26, 1910, and printed in the Illinois Medical Journal, April, 1910, the writer briefly sums up the main facts, as follows:

FIG. 2.

Diagram of caisson used for bridge over River Tyne. *From Thomas Oliver, Diseases of Occupation, New York, 1908.*
A "Material lock". B "Air lock". CDEF Doors. G Inlet valve. H Outlet valve

Effects of Compression: As the air is pumped in there is apt to be a sensation of pressure on the ear drums which soon becomes a severe pain if air is not rapidly swallowed or forced into the tympanum by the Valsalva method. A person with impervious Eustachian tubes may have his drums ruptured if he does not leave the compressed air in time. There is likely to be numbness of the lips, one becomes unable to whistle, there is a sensation of resistance to expiration and the voice becomes high-pitched. According to Erdman,[1] there are no constant changes in the rate of the pulse and respiration or in the blood pressure. When the maximum pressure has been reached, nothing disagreeable is likely to be felt; in fact, there is usually a feeling of exhilaration and increased strength, to which the fact has been attributed that the caisson worker, or "sand hog," as he is called among working men, feels happiest while in compressed air and is a poor worker under normal pressure.

Effects of Decompression: These are far more important than those of compression, and practically all cases of disease originate in too rapid reduction of pressure. The onset of symptoms is usually after normal pressure has been reached. Of 1,419 cases of various types of caisson disease observed by Erdman among the 3,500 workers on the Hudson tunnels, 43 per cent. came on within half an hour, 32 per cent. between one-half and one hour after leaving the caisson, or 75 per cent. within the first hour. The most common phenomena are severe pains in the limbs, chiefly the lower ones, called the "bends," vertigo, known as the "staggers," more rarely dyspnea, the "chokes." Fortunately paralysis, anesthesias and other severe nervous symptoms likely to become permanent are relatively rare. Thus, only 1 per cent. of Erdman's cases had a true paralysis, while pains in the legs were found in 74 per cent. and in the arms in 38 per cent., abdominal pains in 5 per cent., vertigo in 7 per cent.

Silberstern[2] gives statistics of 190 well-studied instances of disease occurring in Vienna. The additional pressure was as high as 2.7 atmospheres. There were 94 cases of pains in muscles and joints, all of which recovered; 35 cases of spinal cord paralysis and "angioparalytic disturbances," with 34 recoveries, while one remained permanently crippled; 17 cases of Měnière's syndrome, with 12 recoveries, 5 completely disabled; 5 cases of other cerebral disturbances, with 4 recoveries and 1 complete disability; 12 cases of asphyxia, with 10 recoveries and 2 deaths; 27 cases of disease of the drum or middle ear, with 26 recoveries and 1 partial disability. (Eleven were cases of hyperemia or extravasation of the drum, 12 hemorrhages into the tympanum, 3 myringitis, 1 suppurative otitis media.)

Fatality: Before proper precautions came into general use, death soon after emerging from a caisson was of frequent occurrence. Thus, according to Rubner,[3] an English company lost 10 to 24 men in one year. Thomas Oliver[4] states that at the building of the Brooklyn bridge there were 110 cases, with 3 deaths, and that of 600 men employed on the St.

[1] Jour. A. M. A., 1907, xlix, 1665.
[2] Weil: Handb. der Arbeiterkrankh., Jena, 1908, p. 612.
[3] Lehrb. der Hygiene, 1907, Ed. 8, p. 48.
[4] Dangerous Trades, London, 1902.

Louis bridge 119 had caisson disease and 14 died. At the first Hudson tunnel there were 12 deaths in one year among the 45 to 50 men employed, i. e., about 25 per cent. mortality, which sank to less than 1 per cent. after a "medical lock" was put in use. The Firth-of-Forth bridge in Scotland, the Blackwell tunnel under the Thames at London and the Baker Street and Waterloo Railway tunnel (the "Bakerloo Tube") were constructed without any fatality.

Most deaths occur within a day or a few days of the onset. Some patients die later from infection arising in connection with urinary retention or bedsores in cases of cord disease which give the clinical picture of disseminated myelitis. Varying degrees of paralysis or sphincter disturbance or Ménière's disease with permanent deafness may be left behind.

Pathologic Anatomy and Pathogenesis: It has been a recognized fact for a long time that the serious symptoms occur during or after return to normal pressure, and the long drawn out controversy concerning the genesis of the symptoms must now be considered settled in favor of the gas bubble theory introduced over 200 years ago. In 1857 Hoppe-Seyler independently evolved this theory on the basis of his own experiments, as he was ignorant of the earlier work of Boyle and Van Musschenbroeck. Still more elaborate and convincing was the work of Paul Bert,[5] whose book appeared in 1878. He brought out all essential facts known today both regarding etiology, symptoms and prophylaxis. In the large book by Heller, Mager and Schrötter[6] all previous work is thoroughly reviewed and many new clinical, anatomical and experimental data added. They fully endorse Paul Bert on every point, including his contention that nitrogen is the main factor in causing trouble. This summary is as follows:

"After rapid decompression free gas may be found in the circulatory system. This gas is nearly altogether nitrogen. If the sojourn in compressed air has been sufficiently long and the decompression rapid pathologic phenomena occur which may be grouped as follows: 1. Severe affections of the heart and lungs which may cause death directly. 2. Disturbances of the central nervous system, chiefly the cord. All those occurrences are due to the presence of free gas in the circulatory system, the cord symptoms being due to gas bubbles in the arteries leading to the formation of multiple foci of necrosis. The phenomena after decompression may generally be removed by recompression, the paralytic phenomena, however, only if textural changes have not yet commenced. The benefit derived from recompression depends upon the shortness of the period between the appearance of symptoms and the recompression, also on the degree and duration of the previous compression. Inhalation of oxygen is of importance, as it directly improves the heart action and respiration and thus indirectly aids in the elimination of nitrogen from the tissues."

Catsaras, in his extensive work (Paris, 1890) on the similar affection among Greek sponge divers, also endorses the gas bubble theory. Heller, Mager and Schrötter have compiled 137 reported deaths from compressed air illness, 41 in divers and 96 in caisson workers, with 45 necropsies. In 70 of the cases with 27 necropsies, death occurred within 48 hours of the onset, in 36 cases longer time had elapsed, while in the remaining ones exact data could not be obtained. In 18 of the 27 necropsies in early cases there are fairly complete records. In 9 evidence

[5] La pression barometrique, Paris, 1878.
[6] Die Luftdruckerkrankungen, Wien., 1900.

of air embolism was found, in most of them sufficiently convincing to exclude the likelihood of invasion by the *Bacillus aerogenes capsulatus* or other gas-producing organisms with which the earlier observers probably were not familiar. In the cases without bubbles there was evidence of passive congestion, such as hyperemia, edema or hemorrhage of the lungs, distended veins in the abdominal viscera and other signs of heart failure ascribed to the heavy work performed in ridding the blood of the excess of nitrogen within it. In the second group, death after two days, the chief findings were foci of ischemic necrosis in the cord and such terminal lesions as cystitis, pyelitis, decubitus and pyemia. It is noteworthy that cases resulted fatally in which apparently sufficiently long time was used in decompression, in one case thirty minutes for an overpressure of 2.3 atmospheres (34 lbs.) and that serious symptoms set in as long as six or seven hours after decompression.

Erdman had 7 necropsies in his New York cases. "Free bubbles or collection of gas were found in the blood in all five cases in which necropsy was performed within eighteen hours after death. The two delayed cases showed no free bubbles." In most of his fatal cases death had occurred within twenty-four hours. Two patients with myelitis and paraplegia succumbed from septic complications after several months.

The pathology of caisson disease is thus seen to be very simple and readily understood if we apply Dalton's law, that the amount of gas in a liquid is proportionate to the pressure of that gas in the atmosphere to which the liquid is exposed. During compression a much increased amount of gas can be held. If decompression is too rapid, gas, in this case mainly nitrogen, is set free and may cause mechanical injury, resulting in various symptoms. The frequency of lesions in the lower part of the spinal cord has been ascribed to "the greater length, tortuosity and attenuated condition of the small blood vessels in this region."[7]

Prophylaxis: The following are the chief points agreed on by all authors: 1. Selection of men. Young men should be preferred, and in many places men over 40 have not been accepted. Snell,[8] among the workers on the Blackwell Tunnel, found no cases of illness among 55 men between the ages of 15 and 20; among 145 men between 20 and 25, 10 per cent., were affected; among 302 between 25 and 40, 23 per cent.; among 38 between 40 and 45, 26 per cent; 3 men between 45 and 50 were taken ill five times, or 166 per cent. Pelton[9] lays stress on a preliminary physical examination, accepting men between 20 and 35 only, and excluding all showing evidence of cardiac, arterial, pulmonary, hepatic or renal disease. He particularly warns against accepting men with signs of status lymphaticus, while he is more lenient as to alcoholism, largely for the practical reason that otherwise it would be difficult to secure enough workers. As before stated, men with disease of the upper air passages or ears are likely to get into trouble during the comparatively harmless stage of compression, and will probably give up the work

[7] Moxon: Cited by Oliver, l.c., p. 747.
[8] Compressed Air Illness, London, 1896.
[9] Amer. Jour. Med. Sc., 1907, cxxxiii, 679.

on the first attempt if not rejected beforehand. 2. The degree and duration of compression must be in inverse proportion and the length of shift regulated accordingly. 3. Sufficient time must be given for decompression. Abundant experience has shown this to be the most important point. In this connection it is well to bear in mind that caisson disease is not a chronic disease in the proper sense, but the result of a trauma produced by liberation of gas bubbles and rupture of minute vessels. If such trauma is guarded against, no caisson disease will occur in men who spend their lifetime at this work, while one single act of carelessness may cripple for life or cause death. It is commonly agreed that it is unsafe to lower the pressure more than two pounds per minute, or one atmosphere in eight minutes. The only modification of this rule which may be accepted, though not without some risk, is that the first half of decompression may be a little more rapid and that individual men after long experience may learn that they can safely come out more rapidly.* However, permitting of exceptions soon leads to carelessness, and it is best to have a rigid, even automatic regulation which makes more rapid exit impossible.

Warm, dry clothing and a drink of hot coffee or soup should be provided on reaching normal air pressure, while beer and other cold drinks should be avoided for some hours.

It is also of importance to furnish an ample supply of air in the caisson, as an undue amount of carbonic acid and the frequent presence of hydrogen sulphid and carbon monoxid lower the workers' resistance to actual caisson disease. Snell observed fewer cases of this illness when ample air was furnished. Only electric light should be used in caissons. Sudden changes in pressure within the caisson must be guarded against, such as sudden rise when a compact stratum of soil is encountered which prevents the escape of air at the lower end. A safety valve will guard against this. Sudden fall of pressure from rupture of the air conducting tube, or, worst of all, instantaneous decompression from rupture of the caisson itself, must be rigidly guarded against, as well as sudden tilting or sinking of it.

Treatment: The time to institute proper treatment is the moment when symptoms appear, which, it will be remembered, is usually within an hour of leaving the compressed air. Their appearance is a sign that the blood contains more gas than it is able to hold in solution and that serious trauma is imminent if the gas is not promptly redissolved. This is readily accomplished if the pressure is raised; that is, by "recompression" of the patient. For this purpose it is essential and should be obligatory to have in readiness a special, so-called medical or hospital lock, and to instruct the men to hurry to it just as soon as they begin to be uncomfortable. Such a lock usually consists of two chambers, the innermost of which is supplied with cots on which the patient may rest until he feels relieved, when he is slowly decompressed. Sometimes a patient has to return several times before he is adjusted to ordinary pressure. Even complete paraplegia often clears up completely by this method. Thus, of Erdman's 21 cases of paralysis 13 were entirely relieved by one recompression, 4 cleared up in from one to ten days, 2 in from two to six

* For discussion of the method of "stage decompression" see Part III.

months, while 3 resulted fatally from subsequent septic complications. Recompression is the only form of treatment which is "specific" for caisson disease. In cases of persistent symptoms due to permanent lesions they are to be treated according to general principles.

III.

Work on Compressed Air Disease Conducted Under Auspices of the British Admiralty.

A very exhaustive investigation of all the problems in connection with compressed air illness was made by Boycott, Damant and Haldane, working at the Lister Institute of Preventive Medicine in England. At the time the British Admiralty had appointed a commission on deep diving, and the investigators mentioned were aided by the Admiralty and, an interesting and encouraging fact, by numerous firms engaged in caisson and diving work. Their paper, over a hundred pages long, was published in 1908.[1] It is subdivided as follows:

Part I. Theoretical.

A. The Rate of Saturation of the Body with Nitrogen During Exposure to Compressed Air.

"When a man or animal is placed in compressed air, the blood passing through the lungs will undoubtedly take up in simple solution an amount of gas which will be increased above normal in proportion to the increase in partial pressure of each gas present in the alveolar air. The experiments of Haldane and Priestly[2], which have since been extended by Hill and Greenwood,[3] show that the partial pressure of carbon dioxide in the alveolar air remains constant with a rise of atmospheric pressure; hence there can be no increase in the amount of carbon dioxide present in the blood during exposure to compressed air. As regards oxygen, the amount in simple solution in the arterial blood certainly increases in proportion to the rise in alveolar oxygen pressure; but as soon as the blood reaches the tissues this extra dissolved oxygen, which (except with exposures to enormous pressures) is only a small part of the total available oxygen in the arterial blood, will be used up, so that in the tissues and venous blood there will be at most only a very slight increase in the partial pressure of oxygen. For practical purposes, therefore, we need only take into consideration the saturation of the body with nitrogen."

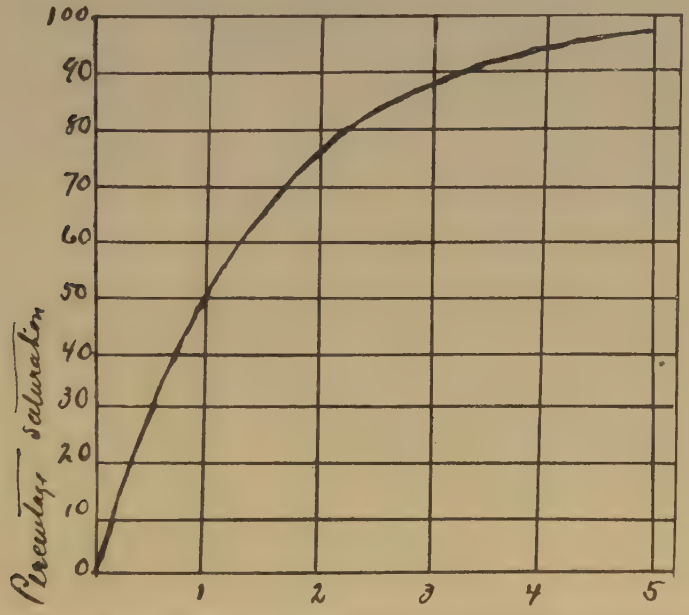
Analysis of experiments by other observers and of their own extensive experiments on goats led them to conclude that the progress of saturation with nitrogen can be graphically represented by a curve which is seen in Fig. 3.

It was found that saturation is approximately complete in about five hours in man, and in a goat in about three hours, which is slower than theoretically expected.

[1] Journal of Hygiene, 1908, Vol. 8, pp. 342-444.
[2] Journal of Physiology, Vol. xxxii (1905), p. 229.
[3] Proc. Roy. Soc., B., Vol. lxxvii, p. 442.

"Equally clear evidence of the existence of a far slower rate of saturation is afforded by the experience of men working in compressed air, particularly in caissons and tunnels at moderate pressures. It is well-known to those practically familiar with such work that the risk of symptoms occurring on decompression depends on the duration of the exposure. There is very little risk on rapid decompression after short exposures of less than than an hour to an excess pressure of two atmospheres or even somewhat higher pressure; but as the duration of exposure

FIG. 3



MULTIPLES OF THE TIME REQUIRED TO PRODUCE HALF-SATURATION.

Curve showing the progress of saturation of any part of the body with nitrogen after any given sudden rise of air pressure. The percentage saturation can be read off on the curve, provided the duration of exposure to the pressure, and the time required to produce half-saturation of the part in question, are both known. Thus a part which half-saturates in one hour would, as shown on the curve, be 30% saturated in half an hour, or 94% saturated in four hours.—(*From Boycott, Damant and Haldane*).

increases hour by hour, so do the risks on decompression increase. We are assured by Mr. E. W. Moir (of the firm of Messrs. S. Pearson and Son, Ltd., Westminster), who has had an exceptionally large experience of tunnelling work in compressed air at excess pressures up to about 2½ atmospheres, that the maximum of risk is not reached after even three hours, so that a limitation of working shifts to three hours markedly diminished the frequency of compressed air illness. Hence in some parts of the body saturation with nitrogen must still be incomplete after three hours. Another observation pointing in the same direction is that when the daily working period was 8½ hours under pressure with two intervals of about 1½ hours each for meals at ordinary atmospheric pressure,

cases of caisson disease usually occurred after the last decompression in the evening and not when the men came out for meals.[4]

Our own observations on animals afford fresh evidence bearing in the same direction. We found that in goats the risks on decompression increase with the length of exposure to pressure up to from two to three hours

In different warm-blooded animals the rate of respiratory exchange varies, roughly speaking, according to the ratio of body surface to weight. The smaller the animals, therefore, the greater is the respiratory exchange per unit of body weight, and the more rapid must be the circulation. In consequence small animals, when placed in compressed air, must saturate their tissues more rapidly in proportion to their more active respiratory exchange; and, conversely, they will free themselves more rapidly, during or after decompression, from the excess of nitrogen. Hence results obtained with small animals as to the time required for complete saturation, or for safe decompression, are not directly applicable to man. We selected goats for our experiments as they were the largest animals which could be conveniently used; but their weights averaged only about one-fourth to one-third of the weight of an adult man. As the surfaces of different mammals are roughly as the cube roots squared of their weights, we should expect that in goats of this size the respiratory exchange per kilo of body weight would be about two-thirds greaater than in man. Direct determinations showed that this was the case. Hence if it required three hours' exposure to a high pressure to effect practically complete saturation[5] of the more slowly saturating tissues of a goat with nitrogen, about five hours would be required for a man. An inspection of Fig. 3 will show that if these tissues became 50 per cent. saturated in about 45 minutes in goats and 75 minutes in man, they would be 94 per cent. saturated in three hours for goats, and in five hours for man. A higher degree of saturation than this would scarcely be appreciable, and we have concluded that for practical purposes any slower rate of saturation than this, and correspondingly slower rate of desaturation, need not be allowed for, unless the percentage of fat in the body is abnormally high. We must admit, however, that there is some evidence, both from our own experiments and from practical experience in work in compressed air, that in the parts of the body which are the seat of 'bends' a still slower rate of saturation may exist."

B. The Rate of Desaturation of the Body With Nitrogen During and After Decompression.

"If the pressure is rapidly diminished to normal after exposure to saturation in compressed air, and no gas bubbles are liberated in the

[4] G. W. M. Boycott, Trans. Inst. of Civil Engineers, Vol. clxv, 1906.

[5] The only method apparently available to determine the time of complete saturation in normal animals is to subject them to a series of experiments in which the pressure and decompression are kept constant and the time of exposure varied, and to observe when the effects cease to become any worse. The method is open to obvious limitations.

body, it is evident that for each part of the body the curve of desaturation will be similar to that of saturation, provided the physiological conditions are constant. The venous blood will give off practically the whole of the excess of dissolved nitrogen during its passage through the lungs[6] and at each round of the circulation will bring back a fresh charge of nitrogen (at the partial pressure existing in the tissues) to be given off. The parts which become half desaturated by this process in a given time will be three-fourths desaturated in double the time, and so on. The slowest saturating tissues will thus, in accordance with our previous calculation, take one and a quarter hours to become half desaturated in man.

"The normal combined gas pressure of nitrogen, oxygen and carbon dioxide in the tissues and venous blood may be estimated as about 90 per cent. of an atmosphere, so that if the nitrogen pressure be more than an eighth above normal the total gas pressure will be above atmospheric pressure. Supposing, therefore, that before decompression the most slowly saturating parts of the body (i. e., those half saturating in one and a quarter hours) had been saturated to an excess pressure of two atmospheres of air, it would take about five hours at atmospheric pressure to reduce this excess pressure to a sixteenth (or an eighth of one atmosphere) and so bring down the total gas pressure in the parts in question to about atmospheric pressure. The slowness of desaturation must be as clearly borne is mind as the slowness of saturation, in connection with all the phenomena of compressed-air illness."

It is pointed out that desaturation is much slower than has hitherto been recognized, and this slowness must be reckoned with in devising measures for the prevention of caisson disease. That the measures which have been proposed to obviate the slowness are inadequate is shown by the following considerations:

In order to increase the difference in nitrogen pressure between the venous blood and the alveolar air, it has been proposed to give a diver oxygen to breathe during, or before decompression. As long, however, as the pressure was above about one atmosphere in excess, or 15 pounds, it would be impossible to do this safely, since, as will be explained more fully below, the effects might be rapidly fatal, owing to oxygen poisoning. The possible applications of oxygen are thus somewhat limited, while the complications involved would be very considerable. The same end can, however, be attained in another way, as will be shown in the following section.

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[6] In view of the enormous surface (probably more than 100 square metres) presented by the lung alveoli for diffusion it seems hardly possible to doubt that the blood during its passage through the lungs becomes saturated or desaturated to almost exactly the pressure of nitrogen in the alveolar air. According to the calculations of Loewy and Zunta (Die physiologischen Grundlagen der Sauerstoff-Therapie in Michaelis' Die Sauerstofftherapie, Berlin, 1904), a difference in partial pressure of oxygen of less than 1 mm. of mercury would account for the diffusion of 250 c.c. of oxygen per minute through the alveolar walls. With a difference in partial pressure of nitrogen of two atmospheres, or 1520 mm. of mercury, between the blood and the alveolar air only about 70 c.c. of nitrogen would require to pass per minute in order to establish complete saturation, or desaturation, of the blood. The conditions are thus enormously more favorable for the taking up or giving off of this nitrogen than for the taking up of oxygen by diffusion during normal respiration.

The rate of blood circulation can be increased considerably by muscular exertion. Quite moderate exertion is sufficient to increase the respiratory exchange to three or four times the normal, and the rate of blood flow hrough the lungs must be increased to something approaching to a corresponding extent. Unfortunately, the increased blood flow is chiefly through the muscles which are working, but probably many parts of the body participate to a greater or less extent in the extra blood supply. Muscular work must correspondingly increase the rate of saturation of the body with nitrogen. For this reason it seems desirable that where work has been done in compressed air, so that the muscles and associated tissues have probably become rapidly saturated with nitrogen, there should also be muscular exertion during decompression. The rate of desaturation will thus be increased so as to compensate for the increased rate of saturation. In the case of short exposures to compressed air, as in diving work, this is specially important. Even, however, when there has been no special muscular work in the compressed air, movements of joints and massage of the skin, etc., will probably hasten desaturation. This has been clearly pointed out by Hill and Greenwood.[7]

C. The Limits of Safety in Decompression.

This chapter is quoted in full as the conclusions here reached form the basis for the practical suggestions for the safe, and yet fairly rapid, method of decompression formulated by these authors and endorsed and further elaborated by Wm. Japp, whose paper will be found abstracted below.

"It is a fact well known to those practically acquainted with work in compressed air that even with very rapid decompression there is no risk of caisson disease unless the pressure has exceeded a certain amount. It seems perfectly clear that no symptoms occur with less than one atmosphere of excess pressure, however long the exposure may be. Whether any distinct symptoms ever occur with less than about 1.25 atmospheres (18½ pounds per square inch or 41 feet of sea water) seems very doubtful; at any rate, they are very exceptional.[8] At pressures a little above 1.25 atmospheres occasional slight cases begin to be observed, and their frequency and gravity rapidly increase with higher pressures unless the time of exposure is limited or slow decompression is resorted to. The lowest pressure at which we have been able to find any record of a death occurring from caisson disease is 23 pounds, or 1.6 atmospheres. As will be seen below, we were able to obtain slight symptoms on rapid decompression in one out of 22 goats after long exposure (four hours) to 1.36 atmospheres or 20 pounds. With 25 pounds (1.7 atmospheres) two cases of slight illness occurred out of 23 animals.

"If the risks of rapid decompression depended simply on the extent to which the blood and tissues are supersaturated with nitrogen on decompression, we should expect to find that even a short exposure to

[7] Proc. Roy. Soc., B., Vol. lxxvii, p. 449, 1906.

[8] In the table of cases included in the present report such cases occurred. See cases 13, 35, 43, 57, 72.

such an excess pressure as two atmospheres would be risky with rapid decompression; for there can be no doubt that within, say, half an hour or forty minutes the tissues, and the blood returning from them, must be for all practical purposes fully saturated in many parts of the body, and particularly in parts of great physiological importance which are richly supplied with blood. Nevertheless, it seems to be well established that a man may stay without serious risk for forty minutes at a pressure which would involve great danger on rapid decompression if he remained in it for several hours.

"Parts of the body with a rapid circulation will become very completely saturated in a comparatively short time, but the highly supersaturated blood which first returns from them on rapid decompression can remain but a very short time supersaturated during each round of the circulation, and on reaching the large veins will mix with less highly saturated blood from other parts of the body. It would seem that the state of high supersaturation in any portion of blood lasts for too short a time to enable bubbles to form.

"If this interpretation of the facts is correct, we should expect to find with small animals, which rapidly saturate and desaturate, that a higher pressure would be required to produce symptoms on rapid decompression after a long exposure than in the case of larger animals. The general experience of previous observers is in accord with this, and our own experiments showed that we could produce no obvious effects in mice, and very few in rabits, rats, and guinea-pigs, by sudden decompression after exposures at pressures which were invariably or frequently fatal to goats.

"Since supersaturation to the extent of about 1.25 atmospheres above normal atmospheric pressure can be borne with impunity, though a greater degree of supersaturation is risky, it seems clear that, in decompressing after prolonged exposure to high pressures, the rate of decompression should be sufficiently slow to prevent any greater excess of saturation than this in any part of the body at the end of decompression. On the other hand, decompression should evidently be as rapid as is possible, consistently with safety. A pressure of 1 to 1.25 atmospheres above normal corresponds to from 2 to 2.25 times the normal atmospheric pressure; but the *volume* (not the *mass*) of gas (measured at the existing pressure) which would be liberated if the whole excess of gas present in supersaturation were given off is the same whether the absolute pressure is reduced from two to one atmospheres, or from four to two, or from eight to four. Hence it seemed probable that, if it is safe to decompress suddenly from two atmospheres of absolute pressure to one, it would be equally safe to decompress from four atmospheres absolute to two, from six atmospheres absolute to three, etc. Our experiments, which are detailed below, have shown that this is the case.[9] The process of desaturation can therefore be hastened very greatly by rapidly reducing the absolute pressure to half, and so arranging the rest of the

[9] Whether the law holds good for pressures much exceeding six atmospheres is still doubtful, as no experimental data exist.

decompression that the saturation in no part of the body shall ever be allowed to correspond to more than about double the air pressure. The main advantage of this plan is that the discharge of nitrogen from the tissues is from the outset of decompression increased to the greatest rate which is safe. The rate of discharge evidently depends on the difference in partial pressure of nitrogen between the venous blood and the alveolar air; and by keeping this difference at the maximum consistent with safety a great saving of time is effected. Detailed investigations have completely justified the adoption of this principle; they are described below, and comprise, besides a series of observations on animals, a number of experiments in which Lieut. Damant and Mr. Catto were exposed to excess pressures up to 80 pounds, or 6.4 atmospheres of absolute pressure, in the experimental chamber, and to 93½ pounds, or 7.4 atmospheres, in actual diving. The method greatly simplifies the problem of safe decompression, and gets rid of many practical difficulties, particularly in connection with deep diving. It may be conveniently referred to as the method of "stage decompression," and is so described in the sequel, though its essential peculiarity does not lie in the decompression being done in stages, but in its being rapid till the absolute pressure is halved and slow afterwards.

D. Practical measures for avoiding compressed-air illness.

"From the foregoing discussion, the general nature of the measures needed to prevent compressed-air illness will be evident enough. The risks may best be avoided by properly calculating stage decompression, or by cutting down the period of exposure to a safe limit, or by both methods combined. In the case of work in compressed air in caissons, tunnels, etc., it is for economic reasons very undesirable to greatly reduce the period of exposure. In diving work, on the other hand, the periods of exposure are generally short in any case, and they can, without great inconvenience, be confined within limits which largely reduce the risks of compressed-air illness. Long periods of decompression are also very undesirable in diving, since changes of weather or tide or other causes may render a return to the surface necessary without any long delay in coming up, and since very prolonged stays under water are exhausting, and the diver's hands may become benumbed by cold."

1. *Diving Work.*

As the present report deals with work in caissons and tunnels, the special peculiarities of diving will be omitted and we will pass to

2. *Work in Caissons and Tunnels.*

"The circumstances connected with work in compressed air in caissons, tunnels, etc., differ in certain respects from those associated with diving work.

"In the first place, the duration of exposure is far longer. A caisson or tunnel worker is usually in compressed air for six or eight hours daily, or even longer. The conditions of the work render any great limitation of the periods of exposure very difficult and expensive. Usually,

however, the workman comes out for meals at intervals of about three hours.

"A second difference is that the very high pressures to which a diver may have to go are not needed in caisson or tunnel work. An excess pressure of about 3¼ atmospheres, or 48 pounds, is, we believe, the extreme limit hitherto employed;[10] and usually the excess pressure does not exceed about two atmospheres, or 30 pounds. Decompression seems to be usually effected in ten to twenty minutes, or even, with the lower pressure, in three to five minutes.

"With properly arranged air-locks for men and material, there should be no need for hurry in coming out; and undue hurry is specially undesirable if the workman leaves the works at once, since he would be liable to develop symptoms when he was so far away that he could not be readily recompressed. To obviate this risk as far as possible, it is customary to endeavor to keep men for half to one hour on the works after they come out; and with the usual rates of uniform decompression this precaution is very necessary. Evidently, however, it is greatly preferable to prevent all practical risks of serious symptoms.

"In order to attain this end stage decompression, as recommended for divers, may be employed. An accurate and easily read pressure gauge, visible from both inside and outside the air-lock, is of course essential; and a reliable man should be in charge of the tap. As a further control, it would be desirable to have an automatic graphic record of the variations of pressure each time the lock for men is used. As any very sudden drop in pressure might cause mechanical injury, the outlet tap should be so arranged as to prevent decompression at a maximum initial rate of more than about one pound in five seconds.[11] With this arrangement and an ordinary tap, the rate of decompression would diminish considerably as the pressure fell, and the proper point for interrupting the decompression could be accurately reached.

TABLE SHOWING RATE OF DECOMPRESSION IN CAISSON AND TUNNEL WORK.

Number of minutes for each pound of decompression after the first rapid stage.

Working pressure in pounds per square inch	After first three hours' exposure	After second or third three hours' exposure, following an interval for a meal.	After six hours or more continuous exposure
18-20 pounds.....	2	3	5
21-24 pounds.....	3	5	7
25-29 pounds.....	5	7	8
30-34 pounds.....	6	7	9
35-39 pounds.....	7	8	9
40-45 pounds.....	7	8	9

[10] Pressure up to 51 or 52 lbs. has frequently been used in America.

[11] The delivery of the inlet tap should also be restricted, and the man in charge should have strict directions to take care that the rate of admission or discharge of air does not cause pain in the ears, etc., of any of the men in the lock. To avoid pain, a very slow rate of air admission may sometimes be needed, but with practice a rise of pressure of one atmosphere per minute is often not too much, so that any definite rule, limiting the rate to much less than this, seems scarcely desirable.

"It will be evident from the last example that, in order to avoid waste of time in the lock, it would be preferable, with pressures exceeding about 25 pounds, to keep the men under pressure continuously during each shift. Thus, with two 3-hour spells of work, separated by a decompression, the time spent in the lock would be 87 plus 100, equalling 187 minutes; whereas, if the meal were taken in the compressed air, the two 3-hour spells would only imply 112 minutes in the lock.

"With working pressure exceeding about 25 pounds the airlock should be roomy and comfortably arranged, and large enough to take the whole of a shift of men. It should be provided with an electric heater, telephone, and if possible some sort of lavatory accommodation.

"With pressures up to 45 pounds, or four atmospheres of absolute pressure, there appears to be no substantial objection to keeping men for six hours, or even more, continuously under pressure, provided that the mode of decompression is thoroughly safe. With pressures exceeding about 40 pounds, the practice has hitherto been to limit the exposure to about one hour, and employ rates of decompression which are dangerously rapid. This plan implies greatly increased risk and expense, since for the accomplishment of the work the number of decompressions is six times as great, and the men are idle most of the day. The actual increase in risk must be very great.

"In tunnel work, or any other kind of work where plenty of space is available, there would be great advantage in providing a large airlock, or section of tunnel, in which the pressure was constantly maintained at a little less than half the absolute pressure in the working section. The men could then pass rapidly (in two or three minutes) from the working section into this intermediate lock or section, where they could take their meals, wash, and change their clothes. After a sufficient delay (dependent on the working pressure) they could then pass out rapidly. If, for instance, the working section was at a pressure of 30 pounds, the intermediate or "purgatory" lock could be kept at an absolute pressure of about $\frac{30 \text{ plus } 15}{2.2} = 20.5$ pounds, or 5½ pounds of excess pressure.[12]. At the end of the day's work there would be a delay of about 50 minutes in this large lock, during which the men could wash and change, or take a meal. With this plan all delays during actual decompression would be obviated, so that ingress and egress would be free at all times, and the men could use the locks employed for material. For persons going in for only short periods the delay in the "purgatory" lock could be curtailed. The movement of the men while employed in washing, changing clothes, etc., would hasten the process of desaturation, and this would be a further advantage.

"In any case where it was specially desirable to reduce the period of delay in the air-lock to a minimum, recourse could of course be had to breathing oxygen during the period of slow decompression. This

[12] A comparatively rapid fall in absolute pressure in the proportion of 2.2 to 1 is within practically safe limits, particularly if the previous period of continued exposure has not exceeded three or four hours.

would about double the rate of desaturation, and therefore halve the delay. The oxygen could be breathed from a bag, and the carbon dioxide absorbed by a purifier, so that very little oxygen would be needed. By so arranging the mouthpiece that part of the expired carbon dioxide was rebreathed, and the respiration and circulation thus stimulated, a still better result would be attained.

"The results of some of our experiments seem to indicate that even the very slow rate of stage decompression which has been recommended above would be insufficient to completely obviate the risk of 'bends' occurring after prolonged exposure. The rate of saturation and desaturation of some of the tissues which are the seat of 'bends' is possibly slower than we have provisionally assumed. What we have aimed at is to completely obviate the risk of any serious symptom, while at the same time reducing the chances of 'bends' to a minimum."

Part II. Experimental.

Extensive experiments on goats were performed and the following conclusions were reached:

"1. The susceptibility of different animals to compressed-air illness increases in general with their size, owing to the corresponding diminution in their rates of circulation.

"2. The average respiratory exchange of goats is about two-thirds more than that of man; they produce about 0.8 gram of carbon dioxide per hour per kilogramme of body weight.

"3. The mass of the blood in goats is 6½ or 7½ per cent of the 'clean' body weight.

"4. The individual variation among goats in their susceptibility to caisson disease is very large. There is no evidence that this depends directly on sex, size or blood-volume; there is some evidence that fatness and activity of respiratory exchange are important factors.

"5. Death is nearly always due to pulmonary air-embolism, and paralysis to blockage of vessels in the spinal cord by air. The cause of 'bends' remains undetermined; there are reasons for supposing that in at least many cases they are due to bubbles in the synovial fluid of the joints.

"6. In our experiments bubbles were found post-mortem most freely in the blood, fat and synovial fluid; they were not uncommon in the substance of the spinal cord, but otherwise were very rarely found in the solid tissues."

The appearance of sections of the spinal cord is seen in Fig. 4.

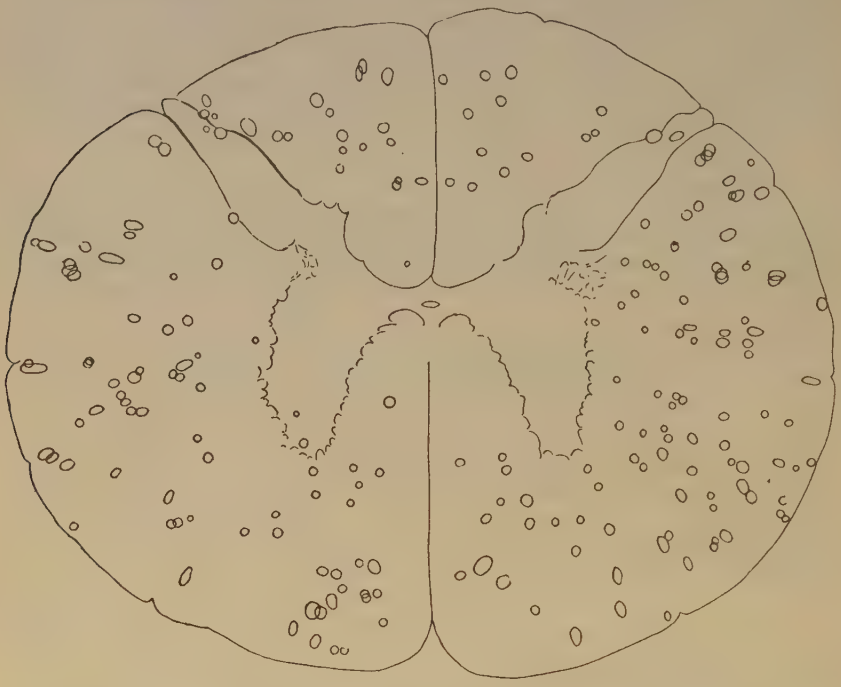

FIG. 4

Showing gas bubbles in the spinal cord of a goat exposed for one hour to pressure of 75 pounds and decompressed in 1¾ minutes; died in ten minutes.

IV.

Abstract of a Recent Article by an Engineer.

Writing from the engineer's point of view, Henry Japp[1] contributes a comprehensive discourse entitled "Caisson Disease and Its Prevention" which is most encouraging, as it shows how thoroughly the author, who was managing engineer at the construction of the East River (Penna. Tunnel and Terminal R. R. Co.) Tunnel, New York, has mastered the physiologic and therapeutic problems which he approached in a scientific, and at the same time eminently practical manner. To quote:

"In the light of past experience, the general conduct of the work was framed on a few established rules which when condensed amount to the following: No workman was allowed to enter the air-chamber without a physical examination by the qualified medical officer of the contractors. Sound physique was the chief requirement. The men were cautioned not to enter the air on an empty stomach, to wear warm clothing on coming out, and to drink hot coffee.

[1] Trans. Am. Soc. of Civil Engineers, Dec. 1909, Vol. 65, p. 1.

"The time worked in the air-chamber was limited to 8 hours, with half an hour off for lunch, up to 32-lb. gauge pressure, and two spells of 3 hours each, with 3 hours rest between, for pressure from 32 to 42 lb., and two spells of 2 hours each for pressures greater than 42 lb., with 4 hours rest between, with no limitation as to decompression. Two medical air locks were installed on each side of the river, well-warmed dressing rooms were provided for the workmen, and there were covered gangways for access to the shafts.

"The air was cooled before delivery to the tunnels, and samples were taken in the tunnels by Mr. Noble's engineers and analyzed daily. The air was regulated so that the carbon dioxide did not exceed 10 parts in 10,000, and the tunnels were kept in a sanitary condition.

"Owing to the grade of the tunnels being so deep on the Manhattan side of the river, the air pressure very quickly rose to 36 lb.

"Practically no cases of bends occurred until the pressure reached 29 lb., and then, within a few days of each other, two men died. These men had entered the air-chamber without being passed by the doctor. Then it became necessary to post outside each air chamber a guard whose duty it was to keep out of the tunnel men who had no doctor's pass. At this time reliance could not be placed on the tunnel foremen, as they were likely to be absent from work, and new men had to be selected each day.

"For many months after the work started, while the men were being seasoned, the tunnel gangs and foremen were in a state of change, owing to the difficulty of getting good men and the frequent absences due to caisson disease, and it was a long time before an efficient organization was built up.

"As the tunnels were driven deeper beneath the East River, the pressure quickly rose, and ultimately reached 36-lb. gauge pressure, with only one set of air-locks in operation; but even the change at 32 lb. from one shift of 8 hours to two shifts of 3 hours each gave no relief, and cases of bends, sometimes fatal, continued all the time.

"It was not long after 27 lb. was reached that the more sensitive members of the staff found that it did not pay to come out quickly, and at 30-lb. pressure it became a custom to take about half a minute for each pound. After one or two additional fatal cases occurred, it was decided to limit the workmen to approximately the same rate of decompression, or actually 15 min. for 35-lb. pressure.

"Many of the men complained that taking so long to decompress gave them caisson disease, and it was difficult to compel them to take long enough. The guards at the entrance to the tunnels had now to record the time taken to decompress, and, as the workmen frequently used the lower muck locks as well as the upper man lock, it was impossible to tell when decompression commenced owing to the noise of exhausting air. Therefore it became necessary to run a small ¼-inch pipe from

the exhaust pipe of each lock to the cabin in which the guard was stationed, a whistle was attached, and a small ball of cotton was suspended by a light string over each pipe. The clerk, noting when the ball was puffed off for each lock, booked the workmen off as they left the lock. The material locks were fitted with inner material valves and, in addition, man valves of smaller size, and a pressure gauge and a clock were fixed in each air-lock.

"As the guard had already booked the men as they entered, he could tell if any were exceeding the regular working shift, and his record was valuable for checking the time-keepers. This rough method of checking the duration of the decompression was quite good enough for the purpose. An attempt to improve it was made when a 12-in. Crosby recording gauge was installed on one air-lock, but it was ineffectual because the air-lock was often sent out or decompressed with no one inside, and this complicated the record, which was much too small, and involved considerable trouble in locating the record of decompression for individual gangs. No doubt a suitable recording instrument could be devised for this special purpose.

"The effect of lengthening the decompression period to 15 min. reduced the number of cases of bends, and no doubt prevented many fatal ones, but they still occurred. As the tunnels had many months to run at high air pressures, the question was: What else can be done to prevent them?

"The writer, on coming out of the tunnel with the workmen, observed that the rate of decompressing was most irregular. One lock tender would allow the air to escape slowly until the 15 min. was almost exhausted, and then, by opening the valve, would let off the remaining pressure very quickly. Others would reverse the process, and exhaust quickly, and then keep the men under 2 or 3 lb. until the time expired. To avoid this a simple decompressing valve was designed which gave a uniform decompression from 35 lb. to atmosphere in 15 min. A somewhat similar one was designed for the medical air-lock, for 1 hour decompression for 35 lb., with an automatic ventilator attached.

"These valves certainly improved conditions, but still fatal cases occurred. After the first valve was under operation, the writer's attention was called to "Modern Tunnel Practice," by D. McN. Stauffer, M. Am. Soc. C. E., wherein a description is given of a needle decompression valve used on the air-locks at the Kiel Dry Dock Works, in Germany. A similar valve was also used for compression. On entering the lock the air was admitted at the rate of 1.5 lb. per min., and was decompressed at the rate of ¾ lb. per min., or, for 35-lb. gauge pressure, 23 min. for entering the air, and 46 min. for leaving. The needle-valve was often frozen up, but otherwise worked well.

"Such speeds seemed altogether too slow, and Mr. Stauffer in his book states that 'these rates would be deemed excessively slow in American caisson practice.' No date is given for the Kiel Dry Dock work, but presumably it was under way in 1904.

"It was not thought advisable to increase the time of decompression at that time, but preliminary tests under air pressure in the tunnels for 1½ hours were then tried for green men, followed by a second medical examination after decompressing in 15 min. A few men were eliminated by this test, and one case of permanent paralysis resulted from the test in 34-lb. gauge pressure. Fresh starters were made to stay in the tunnel for one-quarter of a shift for the first half, and if no caisson disease followed they were allowed to work for the second half. This proved a good safeguard.

"On November 8, 1906, a second bulkhead was put in operation in one of the tunnels, and the pressure between the two bulkheads was reduced to 15-lb. gauge. The number of cases of disease was very small for that tunnel, and as soon as possible additional bulkheads were placed in all four tunnels. The result was to have been expected from the experience in other tunnels where two bulkheads were used; the exercise of the long walk between bulkheads, at low pressure, seemed to assist in driving off the bubbles of air from the blood.

"The workmen were allowed to decompress from 35 to 15 lb. as quickly as they pleased. They then walked for 500 feet along the tunnel under 15 lbs., taking at least 5 min., and then decompressed from 15 lb. to atmosphere in 10 min., so that in all about 16 min. were occupied in decompressing. When the inner pressure was less than 32 lb., an 8-hour shift was worked, with ½ hour interval for lunch, between bulkheads in low air pressure.

"Just when it looked as if the double bulkheads with stage decompression had eliminated fatal and severe cases of caisson disease, two deaths occurred in physically perfect subjects.

"In order to discover, if possible, the connection between the cases of disease and other things, charts were plotted by the medical staff for some months, showing the rise and fall of air pressure, hours worked, humidity, temperature, percentage of carbon dioxide, and number of green men in the tunnel, along with barometer readings, condition of weather, direction of wind, and number of cases of bends. The results were not very encouraging, but it was noted that the number of green men, the height of pressure in the tunnel and the number of cases of bends varied together.

"The percentage of cases in air pressure of 31½ lb. for 8-hour shifts was no more than the percentage in 32½ lb. for two 3-hour shifts—in fact, it was, if anything, less for the longer shift. The decrease in length of shift added one extra gang of men, and probably many of these men being green accounted for this."

The author then reviews Haldane's work advocating "stage decompression" and describes how he profited by it:

"Some time after reading Dr. Haldane's paper and studying his theory, it became necessary to raise the pressure in the tunnels to 40-lb. gauge. It was possible to make the workmen pass through three sets of

air-locks on leaving the tunnel. The inner chamber was kept at 40 lb., the intermediate chamber at 29 lb., and the outer chamber at 12½ lb.

The men were ordered to take five min. in the first lock, 8 min. in the second lock, and 15 min. in the third. There was a distance of approximately 1,000 ft. between each pair of locks. Walking this distance and gathering in the stragglers generally required 10 min. to each chamber, so that, in all, 48 min. were taken to decompress from 40 lb. to atmosphere. No severe or fatal cases resulted, and little time was lost by the men through caisson disease, the cases being only slight. Under this pressure 330 men were employed for 36 days, working 3 hours on, 3 hours off, and 3 hours on. It is true that no green men were used on this work, as there were plenty of experienced air men available at that time.

TABLE 4—(In Japp's Paper.) Decompression Table Based on 9 Minutes Being Safe for 27 Pounds Gauge Pressure.

Gauge pressure in pounds.	Reduce pressure in 3 minutes to	Total time in air-lock after 8 hours' work.	Total time in air-lock after 3 hours' work.	Total time in air-lock after 2 hours' work.
27	6 lb.	9	..	..
30	7½ "	24	..	..
32	8½ "	33	25	..
35	10 "	..	35	..
40	12½ "	..	48	..
42	13½ "	..	51	37
45	15 "	..	..	42
50	17½ "	..	..	48

In caissons or tunnels with but one lock, it is a difficult problem to allow workmen as long a time as Table 4 indicates, as no one can enter the air-lock during decompression. One method of overcoming this difficulty would be to provide a lock with two small end chambers and a larger center chamber, four doors in all being necessary. Anyone making a short visit to the caisson could pass through without disturbing the pressure in the middle decompressing chamber.

Someone has suggested, for diving bells and caissons, a detachable chamber like a boiler, which the men could enter, and thus take as long as necessary to decompress.

The men on the East River tunnels rebelled against 15 min. for decompression, but, after putting the responsibility up to the foremen, in time they found that it was a safeguard and voluntarily lengthened the time to 20 min., and gladly submitted to 48 min. for 40 lb.

The death rate due to caisson disease was comparatively small, averaging 0.19 pct. for the whole of the compressed air work, and, from the experience gained, it would in all probability have been much higher if the decompression had not been lengthened.

The fact that the only recognized cure for caisson disease is recompression in a medical air-lock followed by slow decompression, is a powerful argument in favor of slow decompression, and where it is at all possible, in future works regulated decompression will in all probability be adopted.

In caissons with small air-locks, the volume of air remaining when the lock is full of men is very slight, and very rapid decompression takes place. The workmen have a good opportunity to become seasoned in a caisson, as the pressure begins at 1 or 2 lb. and gradually increases day by day as the caisson sinks, and the highest pressures are required for but a few days.

On the East River tunnels two caissons were sunk to a final pressure of 33½ lb., and very few cases of caisson disease occurred, none of which was fatal, although the decompression was rapid. On the other hand, on account of the tunnels on the Manhattan side starting out at a high pressure, the men had no chance to get seasoned, and many cases occurred, though the time of decompression was regulated, but not to such an extent as Table 4 indicates.

In the discussion, Haldane himself accepted the practical modifications suggested by Mr. Japp. After stating that his own figures were based on experiments made at pressure as high as 75 lb., he continues:

"Work in tunnels and caissons, however, is conducted at much lower pressures; practical experience is much more wide; and, thanks mainly to Mr. Moir, recompression is usually readily available. It becomes a question, therefore, whether the margin of safety which was allowed in decompression cannot be narrowed without appreciable danger. The new evidence which Mr. Japp has brought forward certainly seems to indicate that this is the case. He records the fact that in the construction of the East River tunnel 330 'seasoned' men were employed for 36 days in two 3-hour shifts at a pressure of 40 lb., and were decompressed by a modified form of stage-decompression in 48 min., without a single serious case of caisson disease occurring. Thus there must have been about 24,000 individual decompressions without any mishap. On the principles laid down in the writer's paper, Mr. Japp calculates that the maximum air-saturation left in any part of the bodies of these men at the end of decompression corresponded to a pressure of 27 lb. The writer's calculations agree with this estimate. In view of these results the author proposes to shorten stage-decompression in such a way that in place of the 19 lb. of residual saturation which the writer has proposed, 25 lb. should be left in the case of men who are 'seasoned' to the work. This would greatly shorten stage-decompression, and render it a much more easily practicable process, although the pains in joints, etc., which are the most easily produced and least serious symptoms of caisson disease, would not be prevented.

"The reason for the proposed 19 lb. is that occasional serious cases seem to occur at working pressures down to 20 lb., and that a fatal case

is recorded at 23 lb. On the other hand, there can be little doubt that for the great majority of men a pressure of 25 lb. would not cause appreciable danger. Provided, therefore, that susceptible men can be excluded, Mr. Japp's proposal would seem to be consistent with reasonable safety.

"While a medical examination will probably exclude most of the more susceptible individuals, it still seems very doubtful whether all can be excluded in this way. With new men, therefore, it is desirable that preliminary trials should be made with short shifts, as was the practice in the East River tunnel work. These men should be carefully watched after decompression, and promptly recompressed if they show any threatening symptom; and any man who has shown threatening symptoms should be rejected.

"With these precautions, in addition to having a medical air-lock and keeping the men within reach of recompression for about an hour after they come out, the writer thinks that in all probability Mr. Japp's plan would prove successful. For casual visitors, the duration of stay could be limited, so that on coming out the maximum saturation in their bodies should not exceed 19 lb.

"The conditions vary so widely in different kinds of work in compressed air that it seems hardly desirable to lay down by legislation or otherwise any hard-and-fast general rules as to decompression. The writer, however, thinks that for any particular undertaking in compressed air, special rules, suitable to the particular circumstances, should be drawn up and strictly enforced. If these rules could also have some authoritative sanction, as, for instance, in the case of 'Special Rules' under the Coal Mines Regulation Act in England, engineers and contractors would be relieved to a large extent of what at present must be a very uncomfortable responsibility."

Walter I. Aims, an Engineer, Contributed This Practical Point:

"In nearly all compressed-air work there is difficulty in compelling the workmen to take a reasonable time in the air-lock while decompression. Believing that this is due largely to the extremely uncomfortable conditions in the ordinary air-lock, a method for relieving the lock of the cold and fog when decompressing was used at the Battery-Brooklyn Tunnel, by introducing a constant flow of heated dry air while the lock was being exhausted. In addition to removing the cold and fog from the lock, this heated air also provided for ventilation while decompressing, a feature not found in the ordinary compressed-air lock. The comparative freedom from caisson disease at the Battery-Brooklyn Tunnel, where practically no age limit was established, seemed to indicate the value of thus heating and ventilating the air-lock during the decompression period."

The New York law,[2] which took effect on January 1, 1910, prescribes length of shifts according to the following table (from Japp):

TABLE 5—(FROM JAPP'S ARTICLE

Gauge pressure, in pounds.	Time under pressure	Interval between spells	Uniform decompression, in minutes
0-28	8 hours, less interval	30 consecutive min. spent in the open air	8⅔
28-35.99	2 spells, 3 hr. each	At least 1 hour	24
36-41.99	2 " 2 " "	At least 2 hours	42
42-45.99	2 " 1½ " "	At least 3 hours	46
46-49.99	2 " 1 " "	4 hours	50

No employee shall be permitted to work in pressures exceeding 50 lb. per sq. in. except in cases of emergency.

The decompression shall be at the rate of 3 lb. every 2 min., unless the pressure shall be over 36 lb., in which event the decompression shall be at the rate of 1 lb. per min.

"This law is a great step in advance of anything attempted privately in the United States, and the Commissioner of Labor is to be congratulated, but if these rates are compared with the suggested Table 4 of this paper, it will be found that the new law proposes a greater degree of safety for the lower than for the higher pressures, and inasmuch as the law requires that the decompression shall be uniform, the final pressure in the blood on coming into the atmosphere will be much higher than would result from stage decompression.

"In order that this may be seen more clearly, the writer has calculated the pressure in the blood for various pressures, decompressing uniformly as required by the law, and also by stage decompression, and gives the results in Table 6.

"It will be noted that, whereas the stage decompression proposed fixes the pressure in the blood on emerging from the air-lock at a constant of 25 lb. per sq. in., the uniform decompression periods required by the law give pressures in the blood on emerging varying from 25.70 up to 32.50 lb., such a result being obtained in the case of 50 lb. with 17 min. longer for uniform decompression than stage decompression; and when it is noted that for a pressure as low as 9 lb. per sq. in. the law requires 2 min. for every 3 lb., or 6 min. for decompression, it will be seen how inconsistent are the requirements. In other words, the new law requires

[2] For full text see Part VIII.

generally more time for uniform decompression than is needed for stage decompression, while giving less safety."

TABLE 6.—(FROM JAPP'S PAPER)

Tunnel pressure, in pounds, (gauge)	Time worked, in hours.	Uniform decompression, in minutes.	Pressure in blood on emerging, in pounds.	Stage decompression, in minutes.	Pressure in blood on emerging, in pounds
28.	8	18⅔	25.70	14	25
36.	3	24	30.25	36	25
41.99	2	42	31.25	37	25
45.99	1½	46	32.00	35	25
50.	1	50	32.50	33	25

V.

Contribution to the Study of the Conditions Underlying Compressed Air Disease.

H. Quincke[1] admits that air emboli account for many symptoms of compressed air disease, but points out that the organs most affected are not common seats of embolic processes, and that this discrepancy is not accounted for by the difference in size or nature of the emboli. He ascribes great importance to local liberation of air in cavities and tissue spaces and suggests that the severe pains in the limbs ("bends") may be due to minute air bubbles in the skin, subcutaneous tissues and muscles, particularly in the subcutaneous and interstitial fat, as such minute bubbles may irritate the nerves much more than the larger collections of air which we meet with in the usual forms of subcutaneous emphysema. He lays stress on the special facility with which nitrogen and oxygen are taken up by fats and lipoid substances, which has been proven experimentally both by himself and by Vernon.[2] The affinity of the lipoids of the cord substance for the gases of the air causing them to form bubbles in the tissue spaces, together with the known facility with which air bubbles form in the cerebrospinal fluid, explain, according to Quincke, the frequency of cord affections much better than an exclusive air embolism theory. As the circulation of the blood is more free in the gray matter than in the white matter, and the gases thus more readily carried off, the greater involvement of the white matter is accounted for. The more perfect circulation in the brain and cervical cord as compared with the dorsal and lumbar cord and the extremities which are farther removed from the heart, explain in a way the preponderance of symptoms on the part of the lower half of the cord and the extremities.

Quincke's experiments were of two kinds: 1. Determination of the facility with which the gases of the air are taken up and set free in vitro by the various body fluids and tissues at various rates of pressure. 2. Animal experiments.

[1] Arch. f. exper. Pathol. u. Pharmacol., 1910, 62, p. 464.
[2] Proc. Roy. Soc. Ser. B., 1907, 79, p. 366.

He summarizes his results as follows:

1. In water and 0.9% salt solution oversaturated with air or nitrogen at four or five atmospheres of pressure, air bubbles form and increase in size a few minutes after removal of pressure.

2. In blood serum and albuminous fluids bubbles form much later and are more scanty, the disappearance of the gases taking place more gradually by invisible evaporation. This is still more true of oily fluids.

3. Foreign bodies, such as platinum wire and microscopic crystals, favor bubble formation.

4. Cerebrospinal fluid behaves much more like water than the albuminous transudates.

5. The albuminous transudates seem to absorb less nitrogen than water.

6. Olive oil, cod liver oil (and human fat) absorb three to five times more nitrogen and oxygen than does water.

7. Small animals, such as frogs, mice and rats, after decompression from four to five atmospheres, usually show no symptoms, but liberation of gases in the tissues is demonstrable even 20 or 30 minutes after removal from the pressure chamber.

8. In the killed animal the liberation of gas occurs most freely in the skin, tissue clefts (especially fibrous and adipose tissue), serous cavities and joints, lymph, cerebrospinal fluid and blood capillaries; much less readily in the blood of the large vessels and the heart. It is particularly free in the adipose tissue. The caudal half of the body retains the gases relatively longer than the cephalic portion.

9. The manifold symptoms of caisson disease in man in many cases depend on gas emboli. In other cases they are due to local liberation of gases in the tissue clefts and cavities, such as subcutaneous tissues, joint fluids, cerebrospinal fluid, the endolymph of the vestibule, and the cord substance. For the occurrence and localization of this gas liberation, the amount of circulation of blood and the high solubility of nitrogen in fat are of importance.

Contribution to the Problem of Proper Selection of Men for Compressed Air Work.

J. Plesch[1] of Berlin, in a paper devoted to the prophylaxis and treatment of compresed air illness, hails the stage decompression method advocated by Boycott, Damant and Haldane as a great advance, and calls particular attention to the importance of exercising care in the selection of men for compressed air work. The following six groups of individuals must be excluded:

1. Adipose persons. This discrimination is based on the demonstrated fact that fats and lipoid substances absorb six times more nitrogen than other tissues rich in water.

[1] Berlin Klin. Woch., 1910, Vol. 47, p. 709.

2. Victims of heart lesions, vasomotor weakness (neurasthenia, hysteria), or arteriosclerosis.

3. Victims of chlorosis and other forms of primary and secondary anemia. In such persons the tissues are liable to degenerative processes and very readily lacerated by liberation of air bubbles, even with slight differences in tension.

4. Men with diseases of the central nervous system.

5. Men with edema and subjects of nephritis without edema. Aside from the circulatory weakness, the increased volume of blood and tissue fluids in such persons magnifies the difficulty in disposing of an excess of nitrogen.

6. Victims of ear affections.

VI.

The Occurrence of Compressed Air Diseases in Illinois.

A. Previous Reports.

Aside from Jaminet's[1] classical account of 119 cases of illness, with 14 deaths, at the construction of the first bridge over the Mississippi at St. Louis, the writer has only found the following recorded observations of cases in this state:

Dr. John E. Owens,[2] Chief Surgeon of the Illinois Central and Chicago & Northwestern railways, in a paper on caisson disease read at a meeting of railway surgeons, writes:

"The following case recently came under my care: T. G., 45 years old; employed by Great Lakes Dredging & Towing Company, in a caisson under construction for the Chicago & Northwestern Railway bridge at Kinzie Street, Chicago. He left the caisson too rapidly. When he arrived at the dispensary there was some bleeding from both nostrils; skin of face and hands mottled; complained of weakness; fainting spells; no temperature, but pulse was weak. He had been employed for six years in caisson work and had not lost any time. His recovery was complete in a few days."

In the discussin Dr. Frank Allport of Chicago said:

"I merely wish to report two cases of caisson disease that I remember as having come under my observation.

"In one case, occurring some years ago, the drumhead was ruptured, probably on account of the rarefaction of air in the tympanic space. The entire mucous lining of the tympanic cavity was congested and swollen, presenting the appearance of having been operated on by a suction pump. The other case, which also occurred some years ago, was one of total blindness from hemorrhagic effusions in the choroid, retina and vitreous

[1] 6. Physical Effects of Compressed Air, and of the Causes of Pathological Symptoms Produced on Man by Increased Atmospheric Pressure Employed for the Sinking of Piers, in the Construction of the Illinois and St. Louis Bridge over the Mississippi River at St. Louis, Mo." St. Louis, 1871.

[2] The Railway Surgical Journal, March, 1908.

humor. The vision cleared up from time to time, owing to the absorption of effused blood, but the integrity of the vessel walls had become so impaired that hemorrhage continually recurred until total blindness followed."

B. Personal Observations.

By systematic canvassing, the writer secured interviews with a large number of men who at various times have been engaged in compressed air work in this state and elsewhere. The men who follow this occupation go wherever work is being done. Hence, many residents of Illinois contracted their disease elsewhere and many outsiders have been afflicted here. With the exception of 36 men seen at St. Louis, where a bridge is in construction and where the most serious cases of illness occurred on the Illinois side, all of the men were seen in Chicago.

One hundred and sixty-one cases concerning which fairly reliable data could be obtained are tabulated. There are naturally many inaccuracies, especially as to the exact year in which the attack occurred, the amount of pressure, and particularly the length of decompression, i. e., the time spent in the lock while the air was being let out. Experienced workers say there is a tendency to overestimate the duration of this period, so the figures given are apt to be too high. Even if the figures are correct, it is obvious that this period has generally been very much shorter than it should be. When not otherwise stated the place of work was in Chicago.

Summary of Cases.

Of the 161 men, 87 had various affections of the ear, and 65 of these had resulting impairment of hearing, some of them also more or less permanent ringing in the ears. One hundred and forty-one had pains, chiefly in the limbs, and very severe at first, the so-called "bends." Thirty-four had paralysis, which was generally temporary, though three men have permanent partial paralysis of one arm and two of the legs. Eleven were left with considerable stiffness and pain in bones and joints. Twelve present symptoms of some degree of permanent disease of the spinal cord. Thirteen were delirious or unconscious during the acute attack. Thirty-three complained of dizziness as a prominent symptom, six of vomiting, and eleven of incontinence or retention of urine. Five had numbness without paralysis. Six had "blind staggers" and two had "chokes."

Fatal Cases.

From reliable sources it was learned that three men, two of them negroes, died this year of compressed air disease at East St. Louis (Mississippi bridge), and one during the construction of the Traction bridge at St. Louis. According to the statement of patient 5 in our table, two men died at Rockford on the occasion when he himself had a severe attack, from which he is permanently crippled. The writer has been unable to trace any fatalities directly attributable to compressed air in Chicago. A resident of Chicago died last year of compressed air disease contracted in northern Minnesota.

Benefit of Treatment by Recompression.

Comparison of cases so treated, indicated by "Yes" in column 12, with the others, is very convincing of the advantages of this method.

TABLE OF CASES.

Case No.	Present Age	Number of Attacks	Year	Chief Symptoms	Duration of Attack	Place	Pressure above Normal in pounds	Length of Decompression in Minutes	Interval before Onset	Length of stay in Compressed Air	Treated by Decompression	Present Condition
1	60	Several	1899?	Pains.	Few hours	Oak St. tunnel.	25–35	1	6–7 hours	8	No	Well.
2	41	One	1899	Pains.	3 days	Oak St. tunnel.	16	1	Few min.	8	No	Well.
3	51	One	1901	Pains, paralysis legs.	12 hours.	Oak St. tunnel.	26	5	3 hours.	8	No	Well.
4	52	One	1898	Paralysis of legs.	3 hours	Oak St. tunnel.	27+?	1	Immediately	7	No	Well.
5	46	One	1897	Pains in legs; paralysis of legs.	6 months	Rockford	39	5?	Immediately	2	No	Lame.
6	Dead	One	1898	Paralysis of legs.	Few hours	Oak St. tunnel.	22?	?	Immediately	8?	No	Died of pulmonary tuberculosis.
7	47	One	1898	Pains in arms and legs.	3 days	Oak St. tunnel.	22?	?	Several hours	8?	No	"Rheumatic" pains, hearing impaired.
8	54	1st	1890	Pains in arms and legs; vertigo.	6 hours	4 Mile tunnel.	22	2–3	½ hour	8	No	Crippled; formerly heavy drinker.
		2nd	1890	Pains in legs, vertigo, mental disturbance.	Few hours	4 Mile tunnel.	?	?	Short time	8	No	
		3rd	1893	Vertigo, pains in legs, mental disturbance, sphincter disturbance.	Chronic	4 Mile tunnel.	33–35	3–5	½ hours	8	No	
9	48	One	1893	Pains in neck.	Brief	4 Mile tunnel.	42	1–2	Immediately	11	Yes	Well.
10	37	One	1908?	Pains in legs, mild.	½ hour	Lawrence Ave. tunnel.	8?	?	Immediately	7	No	Drunk when seen: died of pneumonia Sept., 1910.
11	41	Several	1902	Pains in arms and legs.	Few hours	Thebes R. R. Bridge.	Max. 38	15	Gen. 1½ hrs.	4–8	No	Well; works as inspector.
12	38	Two	1899	Pains.	3–4 days	Cleveland tunnel.	40–45	?	?	6–8	No	Well.
13	40?	Several	1906?	Pains.	Few hours	Illinois tunnel.	8–10	?	?	Gen. 8	No	Well.
14	52	1st	1890?	Pains in arms and legs.	3 days	4 Mile tunnel.	26	Few	8–10 hours	8	No	Well.
		2nd	1893?	Pains in arms.	Few hours	68th St. tunnel.	?	Few	?	..	No	
15	42	One	1890	Pains in arms and legs.	1 week	4 Mile tunnel.	28+	?	Short time	8?	No	Well.
16	47	One	1897	Pains in abdomen.	Few hours	68th St. tunnel.	17	Rapid	Immediately	?	No	Well; bricklayer.
17	45?	One	1890?	Pain; bleeding from nose.	Few hours	4 Mile tunnel.	?	?	Soon after	?	No	Well; saloon-keeper.
18	48	2–3	1892–'90-92	Deafness.	5 weeks	4 Mile tunnel.	22	5?	Immediately	..	No	Impaired hearing.
				Pains in arms.	Few hours	4 Mile tunnel.	?	5?	Soon after	8–16 hours	No	
19	32	Three	1902	Pains in arms.	Sev'l days	Cleveland.	48	5	1–2 hours	8	No	Well.
20	42	1st	1892	Pains and vertigo.	2–3 weeks	4 Mile tunnel.	28–30	Very rapid	2 hours	8?	No	Well.
		2nd	1903	"Blocked."	Few days	Illinois tunnel.	15	?	On entrance	8?	No	
21	43	One	1900?	Pains in legs.	6 hours	Oak St. tunnel.	17+?	3	7 hours	8	No	Well.
22	34	One	1893?	"Blocked," deafness, vertigo, mental disturb.	1 month	4 Mile tunnel.	27	?	2½ hours	8–10	No	Occasional vertigo.
23	38	1st	1893	"Blocked" (bleeding right ear; deafness).	2 weeks	4 Mile tunnel.	?	?	On entrance	..	No	Right knee permanently disabled; very lame.
		2nd	1898	Pains.	2 days	Oak St. tunnel.	28–32	3–5	.....	8	No	

24	33	5–6	1906	"Blocked;" deafness; pains in arms, legs and abdomen.	Sev'l wks. ear disch.	Lawrence Ave. tunnel.	15?	?	Onset before & during work	8	Once	Moderately impaired hearing.
25	?	Several	1888	Pains in arms and legs.	Few hours 2 days	Cleveland tunnel.	30	?	Short	?	No	Well.
26	36	1st	1898	Pains in arms and legs, deafness. vertigo.	3–4 days	Oak St. tunnel.	39	5	1 hour or less	8	No	Impaired hearing, right ear.
		2nd	1898	Pains in arms and legs.	.....	Oak St. tunnel.	Max. 39	Few	Short	8	No	
27	50	One	1893?	Pains in abdomen.	3 hours	68th St. tunnel.	30	3	Short		Yes	Well.
28	48	1st	1898?	Pains in arms and legs, deafness, bleeding nose.	4–5 hours 4–5 hours	Oak St. tunnel.	40? Variable	15 Variable	1 hour	8 Gen. 8	No	Well.
		Several	1898	Pains.	longest 3 dys.	Oak St. and 68th St. tunnels.						
29	54	One	1893	Pains in arms and legs; paralysis legs; mental disturbance.	1 month	68th St. tunnel.	20–27	1–1½	½ hour	18	No	Well.
30	40	1st	1902	Paralysis of legs.	2 weeks	Cleveland tunnel	45	15	Short	4 hours	No Yes	Well, aside from occasional rheumatic pains last 12 years.
		2nd	1910	Pains in legs.	1 hour ?	Hibbing, Minn.	47	?	Short	1 hour	In look 45 min.	
31	53	One	1890	Deafness; vertigo.	Chronic	4 Mile tunnel.	?	?	?	8?	No	Permanent deafness; mental deterioration.
32	62	One	1894	Pains in legs and arms.	Sev'l hours	Oak St. tunnel.	30	6–10	2 hours	8	No	Well; works for water pipe exten. dept.
33	43	1st	1898	Blocked; deafness; vertigo.	1 week	39th St. tunnel.	10+	?	Immediately	8	No	Now plumber; impaired hearing.
		2nd	1906	Pain in legs; sphincter disturbance.	2 weeks	Illinois tunnel.	15	5	Short	8?	No	
34	32	One	1907	Paralysis legs; pain legs.	2 days	Mobridge, S. D.	38	3–4	¾ hours	3	No	Impaired hearing since blocked several times.
35	37	One	1901	Pain in legs; deafness.	Some hour	Illinois tunnel.	12	10?	Sev'l hours	8	No	Right ear deaf.
36	41	One	1891	Pain in chest.	3 days	4 Mile tunnel.	20	2	Immediately	8	No	Well; works in sewers.
37	44	1st	?	Pains in legs and arms.	4 weeks in hosp.	Cleveland tunnel.	48	4	Short	2	No	Deaf; walks lame; signs of permanent spinal cord lesion. Does some work; lives in Chicago.
		2nd	1892?	Pains in legs and arms.	31 days	4 Mile tunnel.	27–30	3	Short	8?	No	
		3rd	1910	Pains in legs, arms and abdomen; paralysis legs; sphincter disturb.; deafness.	2 months	Hibbing, Minn.	38–40	1½	Immediately	2	Yes	
38	62	1st	1890?	Pains legs and abdomen.	10 hours	4 Mile tunnel.	25	Few	Few minutes	16	No	Well.
		2nd	1890?	Pains in legs.	8 hours	4 Mile tunnel.	23	Few	Few minutes	8	No	
39	?	One	1908	Pains in legs and arms.	3 days	Gary, Ind., tunnel.	20–25	2	½ hour	10	No	Well.
40	33	1st	1908	Pain in arms and chest.	3 days	Gwinn, Mich.	47	2	2 hours	40	Yes	Well.
		2nd	1909	"Blocked;" deafness.	1 week	N. W. Depot, Chicago.	25	1	Onset at ent.	?	No	
41	34	1st	1896	Pain in legs and arms.	2 weeks	New York (Bridge).	48	15–less	Few hours	40	No	Well.
		2nd	1898	Paralysis of legs.	Few hours	Hudson tunnel.	42	?	?	2	Yes.	
		3rd	1904	Paralysis of legs.	Few hours	King's Bridge, N. Y.	45	?	?	1	Yes	
		4th	1909	Paralysis of legs.	Few hours	Gwinn, Mich.	37	?	?	2	Yes	

TABLE OF CASES—Continued.

Case No.	Present Age	Number of Attacks	Year	Chief Symptoms	Duration of Attack	Place	Pressure above Normal in pounds	Length of Decompression in Minutes	Interval before Onset	Length of stay in Compressed Air	Treated by Decompression	Present Condition
42	43	One	1890	Pain legs, arms, abdomen.	1 day	4 Mile tunnel.	18	1–2	½ hour	8	No	Well; policeman last 17 years.
43	57	One	1900	Blocked, deafness, pain in head.	1 week	39th St. tunnel.	7	?	Onset at ent.		No	Left ear deaf.
44	43	One	1895	Pain legs, several times tinnitus.	20 hours	Oak St. tunnel.	36	?	2 hours	8	No	Hearing impaired; works for city.
45	54	One	1892	Pain in legs.	12 ? hours	4 Mile tunnel.	27 or less	2	1 hour	8	No	Well; in Dept. Public Works.
46	34	One	1907	Blocked; deafness, bleeding from nose.	deaf 1 week	Kinzie St. R. R. Bridge.	15–20	1–2	Onset on entrance	8	No	Well.
47	67	One	1899	Pains in legs.	perma. joint dis.	Oak St. tunnel.	30	Few	1 hour?	8	No	Lameness and pain in legs ever since. Worked only 2 shifts in compressed air. Carpenter. Not worked since accident.
48	38	1st	1903	Pain legs; paralysis legs; deafness; vertigo; bleeding from nose.	2 weeks	New York (building).	33	2–3	Onset during work when pressure suddenly raised.	4	No	Intemperate.
		2nd	1904	Pains; bleeding from nose; deafness	1 week pain; ear eisch. 4 months	Daney, W. Va.	32	3	Worse on exit	4	No	Impaired hearing left ear; pains in legs after drinking.
49	63	One	1891	Pain back, chest, arms, legs.	7 months in bed 2 weeks	Ishpeming, Mich.	18	Few	Sev'l hours	?	No	Well.
50	30	One	1907	"Blocked;" deafness.	L. ear deaf 2 months	Kinzie St. R. R. Bridge.	15	?	Onset on entrance	8	No	Well; building laborer.
51	39	One	1902	"Blocked;" deafness; bleeding from nose; and ears; vertigo; pain in head.	Pain 2 weeks	39th St. tunnel.	35	15	Onset on entrance	Few hours	No	Impaired hearing left ear.
52	51	One	1908	"Blocked;" bleeding from nose and ears; vertigo; deafness.	5 days in bed	Mobridge, S. D.	24?	4	Onset on entrance	2	No	Left ear partly deaf.
53	52	One	1887	Pain legs; deafness; bleeding from nose.	3 days	Cleveland tunnel.	31 general	?	Short	8	No	Hearing poor; frequent pains in legs.
		Several	'90-92	(Same symptoms).	½-1 day	4 Mile tunnel.	22?	?	Gen'l short	8	No	
		5 or 6	?	Pain legs; deafness.	?	Milwaukee, Wis.	29	?	?	?	No	
54	36	1st	Between 1890	Pains in legs.	3 days	Cleveland tunnel.	36	1½–2	½ hour	8	No	

		2nd	and 1900	"Blocked;" deafness; bleeding from ears pain in head.	L. ear deaf 6 months	Cleveland tunnel.	?		"Blocked" on entrance. Hemorrhage 1 hour after exit	2	No	Impaired hearing left ear. Pain back and left leg since paralyzed.
		3rd	1910	Paralysis of legs.	2 hours	Gwinn, Mich.	45	15	15 minutes	1	Yes	
55	56	1st	1900?	"Blocked;" bleeding from nose and ears, deafness.	2 weeks in hosp.	Omaha, R. R. Bridge.	42	?	Onset on entrance.	Few min.	No	Hearing very poor.
		2nd	?	Pains in arms and legs.	16 hours	Oklahoma.	26	?	½ hour	8	No	Compressed air work last 20 years.
56	48	1st	1890?	Pains in legs, back, head, arms; vertigo; bleeding from nose; deafness.	2 weeks	4 Mile tunnel.	18–20	Few	Short	8	No	Occasional pains in left hip and in back on left side.
		2nd	1907	Pains as before.	3 weeks	Mobridge, S. D.	22	Few	Short	8	No	
		3rd	1908	Pains in back and legs.	5 weeks	Kinzie St. R. R. bridge.	26	Few	Short	8	No	
57	25	One	1901	Deafness; earache.	1 week	Illinois tunnel.	9	?	Immediately		No	Well.
58	39	One	1899	"Blocked;" bleeding from nose and ears; deafness; vertigo; mental disturb. pain in back and legs.	Ear discharge 6 months	Illinois tunnel.	19	?	Onset on entrance	Few minutes	No	Left ear totally deaf. Stiffness of left knee.
59	43	One	1890	Bleeding nose and ears; pain in head; vertigo; pain in legs.	Permanently lame. Couldn't work for 27 months	4 Mile tunnel.	25	1–2	Onset in tunnel	25	No	Spinal cord and joint lesions; Impaired hearing; does light work.
60	28	One	1910	Earache; vertigo; bleeding nose and ears; pain in legs.	2 days	Hibbing, Minn.	47	10	½ hour	45	Yes	Deafness; slight stiffness left knee.
61	42	One	1904	Paralysis of legs; pains in arms, abdomen, chest, back; vomiting.	3 weeks	Thebes, R. R. bridge.	30–35	2 3	20 minutes	8	No	Pain in left side when working hard. Cement worker.
62	27	One	1907	"Blocked;" bleeding nose and ears; deafness.	Severe tinnitus 3 months	Illinois tunnel.	12	10	Onset on entrance	10	No	Partial deafness. In compressed air only on this occasion.
63	38	One	?	Vomiting; pain in legs and chest; paralysis of legs; sphincter disturbance.	1 month	Cleveland tunnel.	39	?	Onset during work	8	No	Well.
64	49	One	1908	Bleeding from nose and ears. Tinnitus.	Tinnitus 3 days	Peoria bridge.	15	5–10	Onset during work	2	No	Partial deafness.
65	44	1st	1891?	Pain in legs.	1 day	4 Mile tunnel.	22	Few	Short	8?	No	Impaired hearing since "blocked" at Cleveland.
		2nd	?	Pain in legs.	1 day	Cleveland tunnel.	27	?	?	3	No	
		3rd	1908	Numb from waist down.	½ day	Gwinn, Mich.	48	?	Short	40	Yes	Precipitate urination since attack at Gwinn.
66	38	Two	1893	Bleeding from nose and ears; vertigo; tinnitus; second attack, pain in legs.	7 weeks 2 weeks	68th St. tunnel.	22–24	?	Onset during work	3 hours	No	Well except slightly impaired hearing.
67	41	One	1900	"Blocked;" bleeding from nose; pain in legs; deafness.	1 week	Illinois tunnel.	22	?	Onset during work	4	No	Impaired hearing.

TABLE OF CASES—Continued.

Case No.	Present Age	Number of Attacks	Year	Chief Symptoms	Duration of Attack	Place	Pressure above Normal in pounds	Length of Decompression in Minutes	Interval before Onset	Length of stay in Compressed Air	Treated by Decompression	Present Condition
68	55	Several	1892	Pain in legs; tinnitus.	?	4 Mile tunnel.	14–16	Few	Variable	8	No	Impaired hearing; persistent tinnitus; stiff and painful legs; intemperate.
69	38	One	1905	"Blind Staggers."	1 week	Gila, Ariz. bridge.	40	8	Onset during work, when pressure suddenly was raised.	?	No	Well.
70	35	1st	1909	Pain in arms and legs.	4 hours	N. W. Depot, Chicago.	22	3–5	Short entrance.	8?	No	Well.
		2nd	1910	"Blocked;" bleeding from ears; deafness.	2 days	Hibbing, Minn.	30	?	Onset on entrance	Few min.	No	
		3rd	1910	Pain in legs.	2 days	Hibbing, Minn.	42	5	½ hour Tem. —35° F.	45 minutes	Yes	
71	35	1st	1900?	"Blocked;" bleeding from nose and ears; vertigo.	2 days	Hudson tunnel.	23	?	Onset on entrance	Few minutes	No	Pains in limbs for one year after Detroit attack. Now well. Porter in hotel.
		2nd	1908	Pains in arms, neck and legs.	12 hours	Detroit tunnel.	17	5	Onset during wMrk; worse after decompression.	3	No	
		3rd	1908 1 day after 2d at.	Pain in legs.	1 month	Detroit tunnel.	20	?	Onset during work.	½ hour	No	
72	39	1st	1905	Vertigo; bleeding from nose and ears; pains in legs and back; sphincter disturbance.	4 weeks	East Boston tunnel.	26	8–10	Immediately	4	No	Frequent joint swellings. General nervousness; now salesman.
		2nd	1905	Bleeding from nose; vertigo; pains in legs, back.	4 weeks	East Boston tunnel.	14	10?	Immediately	4		
73	38	One	1906	Bleeding from nose and ears; pains in head and back; and legs; mental disturbance; deafness.	8 weeks	Lawrence Ave. tunnel.	15	?	Onset during work.	1–2	No	Impaired hearing; general nervousness. Cook.
74	31	One	1906	Bleeding from nose and ears; pains in back, head and legs; mental disturbance.	2 weeks	Lawrence Ave. tunnel.	16	?	Onset during work.	2	No	Impaired hearing; occasional pain in left leg. Cook.
75	47	1st	1896	Bleeding from nose and ears; vertigo; pain in head; mental disturbance; pain in neck; vomiting; sphincter disturbance.	3 weeks	Cleveland tunnel.	32	?	Onset during work.	1½	No	Spinal cord lesion. Slight pain in legs.

		2nd	1896	Tinnitus; bleeding from nose and ears; pains.	3 days	Cleveland tunnel.	?	?	Onset during work.	3 hours	No	
76	27	1st	1907	Pain in abdomen, arms and legs; bleeding from nose and ears; deafness.	3–4 weeks	Gary, Ind., tunnel.	19	3–4	Few minutes.	8 hours	No	Impaired hearing. Otherwise well.
		2nd	1907	Bleeding from ears; pain in arms and legs.	11 days	Gary, Ind., tunnel.	?	?	?	8 hours	No	
		3rd	1908	Pains in legs; bleeding from ears.	1 week.	East St. Louis Bridge.	22	2	Few minutes.	6	No	
		4th	1908	Pains in arms, legs, abdomen; tinnitus; deafness.	3 weeks.	East St. Louis bridge.	?	?	?	?	No	
77	41	1st	1900	Pains in arms and legs.	24 hours.	Cleveland tunnel.	38	?	1 hour.	8	No	Well.
		2nd	1900	Pains in arms and legs.	24 hours.	Cleveland tunnel.	45	?	?	6	No	
78	32	Several	1898 to '03	"Blocked;" bleeding from nose and ears; deafness.	Few hours.	Hudson tunnel.	18–23	?	Onset gener. on entrance.	Variable	No	Left external ear torn off and face lacerated from explosion of compressor in New York. Impaired hearing.
		Several	1908	"Blocked;" bleeding from nose and ears; deafness	Few hours.	Detroit.	15	?	Onset gener. on entrance.	?	No	
79	40	1st	1902	Pains in legs and arms.	4 hours.	Hudson tunnel.	38	5	½ hour.	3 hours.	No	
		2nd	1909	Pains in arms.	15 minutes.	Gwinn, Mich.	46	8–10	Immediately	40 minutes.	No	Well.
		3rd	1910	Numb from hips down.	1 hour.	Hibbing, Mich.	42	25	15 minutes.	1 hour.	Yes	
		4th	1910	Pains in arms.	1 hour.	East St. Louis bridge.	49	25	Short	1	No	
80	38	1st	1910	Pains in legs.	3 days.	Hibbing, Minn.	42	10	Immediately	1½	Yes	
		2nd	1910	"Blocked;" tinnitus; ear discharge.	Chronic.	Hibbing, Minn.	43	?	Onset on entrance.	?	No	Impaired hearing; discharge from left ear and tinnitus continue.
81	45	One	1900	Vertigo, tinnitus, pains in legs, back and arms; sphincter disturbance.	1 month.	Cleveland tunnel.	18–25	?	Immediately	8	No	Well, except slightly impaired hearing.
82	28	One	1904	Pains in legs; paralysis of legs.	1 week.	Hudson tunnel.	35	4–5	3 minutes.	?	No	
		2nd	1904	Pains in legs; paralysis of legs.	5 weeks.	Hudson tunnel.	42	Few	Immediately	1	No	Well.
		3rd	1907	Pains in arms.	5 days.	Kinzie St. R. R. bridge.	25	Few	Immediately	8	No	
83	50	One	1908?	Bleeding from nose and ears, "blind staggers," pains in legs.	3 days.	Clinton Ia., R. R. bridge.	15–18	?	Onset of ear trouble during work. Pain after exit.	1	No	Impaired hearing and tinnitus.
84	56	One	1899	Bleeding from nose and ears; vertigo; unconsciousness, tinnitus, deafness.	2 weeks.	Detroit, Mich.	17	?	Onset on entrance.	Few minutes.	No	Marked deafness; persistent tinnitus.
85	48	1st	1890	Pains in arms; paralysis of arms.	1 day.	4 Mile tunnel.	25	Few	Immediately	8	Yes	Well.
		2nd	1908	Pains in legs.	4 days	Kinzie St. R. R. bridge.	25	?	Immediately	8	No	
86	38	Several	1905	Bleeding from nose; vertigo; tinnitus.	Few hours.	Gilbertsville, Ky., bridge.	16–17	?	Immediately	?	No	
		Several	1908	Same as before but not severe.	Few hours.	Clinton, Ia., R. R. bridge.	16–17	?	Nose bleed on entrance; other symptoms immediately after exit.	?	No	Well.

TABLE OF CASES—Continued.

Case No.	Present Age	Number of Attacks	Year	Chief Symptoms	Duration of Attack	Place	Pressure above Normal in pounds	Length of Decompression in Minutes	Interval before Onset	Length of stay in Compressed Air	Treated by Decompression	Present Condition
87	49	1st	1900	Pains in legs.	5 days.	Cleveland tunnel.	25	5	Immediately	?	No	Occasional pain in left side; hearing slightly impaired.
		2nd	1900	Pains in legs and abdomen; tinnitus, bleeding from nose and ears.	3 weeks.	Cleveland tunnel.	25	?	Immediately	?	No	
		3rd	1902	Vertigo, pains in legs, abdomen and back; unconscious.	5 weeks.	Thebes Ill.	28–34	?	Short	8	No	
		4th	1902	Pains in legs.	5 days.	Thebes Ill.		?	Onset during work.	8	No	
		5th	1902	Vertigo, tinnitus, deafness.	deafness 3 weeks.	Thebes, Ill.		?	?	8	No	
		6th	1907	Pains in abdomen, legs, and arms; vomiting, bleeding from nose and ears, vertigo.	1 month.	Mobridge, S. D.	28	6	Short	3	No	
88	36	3	1907	"Blocked;" bleeding from nose and ears; vertigo.	Longest 4 weeks.	Gary, Ind.	24–25	Few	? (Look tender.)	?	No	Well.
		2	1907	Pains in legs.	1st 3 days 2nd 2 weeks	Gary, Ind.	24–25	2–3	Onset during work.	?		
89	31	Several	1904	"Blocked;" bleeding from ears; vertigo.	Once. Ear discharge 2 weeks.	Illinois tunnel.	15–25 40	?	?	8?	No	Hearing in left ear slightly impaired.
		Several	1910	"Blocked."		Hibbing, Minn., and St. Louis bridge.	25–30	?	"Blocked" on entrance.	?	No	
90	50	One	1908	Vertigo; unconscious, bleeding from nose and ears; vomiting.	In bed 3 days ear discharge 3 months.	St. Louis Traction bridge.	10–15	?	Onset during work.	1	No	Intemperate. Slight impairment of hearing.
91	49	1st	1890	Pains in arms.	24 hours.	Memphis, Tenn., bridge.	45	7–8	Short	45 minutes	No	
		2nd	1890	Pains in legs.	4 days.	Memphis, Tenn., bridge.	45	7–8	4 hours.	45 minutes.	No	Well.
		3rd	1910	Pains in legs.	2 hours.	Arkansas (bridge).	38	8–10	Short	2	No	
92	41	One	1904	Pain all over; weakness.	In hosp. 2 weeks.	Thebes, Ill., bridge.	38	2	Immediately	8	No	Well; not in compressed air since.
93	28	1st	1908	Tinnitus, vertigo. bleeding nose and ears; pains in abdomen and back.	Pain 6 hours. Too weak to work 3 weeks.	Hudson tunnel.	35	10–15	Onset during work.	2	No	Well.
		2nd	1908	Pains as before.	1 week.	East River tunnel, N. Y.	40	?	Onset during work.	2	No	
94	34	1st	1904	Vertigo; pain in ears and legs.	6 hours.	Elgin water tunnel.	25–30	?	Ear trouble during work. Pain immediately after.	8	No	Hearing impaired. Digestion easily upset.

		2nd	1909	Bleeding from nose and ears; vertigo; vomiting; occipital pain; pain in abdomen.	2 days.	East End tunnel, N. Y.	35–40	?	Onset during work.	1	Yes	
95	50	1st	1882	Pain in back and sides.	In bed 3 weeks.	Hudson tunnel.	35–40	?	1 hour.	4	No	Impaired hearing; occasional dizziness and tinnitus.
		2nd	1903	Vertigo; headache; bleeding from ears.	Persistent.	39th St. tunnel.	22	?	Onset during work.	7		
96	27	1st	1901	Pains in legs.	?18 hours	Cleveland tunnel.	35	?	Gen. ½ hour	8	No	Hearing impaired.
		2nd	1901	"Blocked;" bled from nose and ears; tinnitus.	Deaf several weeks	Cleveland tunnel.						Occasional pain in knees.
		3rd	1904	Pain in knees.	1–3 days	East River tunnel N. Y.	Max. 45 ?	30	Short	1	No	
97	40	Several	1902?	"Blocked" several times; pain in legs twice.	Few days.	Illinois tunnel.	10?	Few	Pain soon after exit.	8	No	Impaired hearing rig ear.
		2nd	1908	Pain in legs.	2 days.	Gary, Ind., tunnel.	Max. 30	4–5	1 hour.	8		
98	48	One	1900	Pain right arm and leg.	48 hours.	Cleveland tunnel.	42	3	1 hour.	8	No	"Blocked" several times at various places. In good health.
99	44	Several	1890	Pains in arms and legs.	Few hours.	4 Mile tunnel.	18	?	Short	8	No	
		Several	1895	Pain right ear; tinnitus several times.		Tunnel at Western and Belmont Aves.	Max. 38	?		?	No	Well. Policeman last 10 years.
		Several	1898?	Pain knees and elbows.	15 hours.	Oak St. tunnel.	25	?	Short	8	No	
100	49	Several	1890 to '02	Pain in right leg.	Few hours.	Port Huron tunnel, Mich.	Max. 35	Few	Immediately	?	No	Quit compressed air work on account of pain in right knee becoming constant.
		Several	1895?	Pain in right leg.	Longest 1 week.	Cleveland tunnel.	?	?	?	No	No	
		Two	1900	Pain in right leg.	?	Cincinnati tunnel.	42	?	?	1	No	
101	38	1st	1902?	Pain in abdomen, knees and arms.	2 days	Thebes, Ill., bridge.	38	1½	Immediately	2	No	Left ear partly deaf.
		2nd	1910	Pain in abdomen and knees, vomiting, bleeding from ears and nose; delirious.	3 days	Hibbing, Minn.	36	1	Immediately	1½	No	
102	47	One	1896	Pain right knee.	8 hours	Oak St. tunnel.	26–32	1½	Few hours	6	No	Well. Works in sewers.
103	25	1st	1906	Pains in hips, legs and arms; bleeding nose and ears; tinnitus, vertigo.	2 hours	Tunnel, N. Y.	42	30	Immediately	1	Yes	Left ear deaf with tinnitus.
		2nd	1909	Pains hips, legs, arms; bleeding nose and ears.	24 hours	N. W. Depot, Chicago.	29	5	Immediately	8		
104	35	1st	1909	Pain right leg.	4–6 hours	N. W. Depot.	27	Few	1 hour ?	8	No	Well. Intemperate.
		2nd	1909	Pain, tinnitus and deafness in left ear.	Deaf 2 weeks	N. W. Depot.	25–30			'8	No	
105	27	1st	1905	Pain left arm and knee; bled from nose and left ear; tinnitus; deafness.	2 days	Quebec bridge.	38–40	2	Few minutes	2	No	Impaired hearing in left ear.
		2nd	1906	Headache; vertigo; bleeding nose and left ear.	2 days	Omaha, Nebr., bridge.	49	?	Immediately	2	No	Weakness in right leg.
		3rd	1906	Pain right hip and thigh; paralysis right leg; retention of urine (?).	4 weeks	Omaha.	60 (?)	?	Onset during work. Worse on exit	Few minutes	No	

TABLE OF CASES—Continued.

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106	28	One	1903	Severe pain especially abdomen and legs; delirious.	At least 1 month	Arkansas (bridge).	35	2	5 minutes	2	No	Intemperate. Otherwise well.
107	37	One	1898	Pain left arm.	5 weeks	68th St. tunnel.	18–24	3	Onset during work	2	No	Left arm slightly weak; probably from spinal cord lesion. Analgesic area on forearm.
108	48	1st	1900?	"Blocked;" tinnitus bled from nose and ears; pain arms, knees, abdomen and back; vertigo.	2 days	68th St. tunnel.	22	?	Immediately	?	No	
		2nd	1907	"Blocked;" bleeding ears and nose; pain in arms and knees.	3 days	Kinzie St. R. R. bridge.	?	?	Onset on entrance; pain worse on exit	?	No	Hearing impaired.
109	35	One	1900	Paresthesia and pain in legs; tinnitus, vertigo, headache.	In bed 10 days	39th St. tunnel.	24–26	1½	Onset during work	3	No	Impaired hearing right ear; not in compressed air since attack.
110	50.	1st	1896?	Nosebleed, tinnitus, vertigo, headache, numbness left ring and little fingers and right heel.	1 week	68th St. tunnel.	20	5?	Immediately	?	Yes	Left ring and little fingers still analgesic.
		2nd	1896	Tinnitus, headache, vertigo.	1 day	68th St. tunnel.	20	?	Immediately	?	Yes	
111	41	1st	1890	Twitchings and pain in arms.	8 hours	4 Mile tunnel.	18–21	Short	Short	7½	No	Partial paralysis left shoulder; anesthesia above spine of scapula.
		2nd	1896	Pain in chest and shoulder.	4 days	Cleveland tunnel.	34	2½	Immediately	9	Yes	Occasional pain in left shoulder.
112	37	One	1895?	Pain knees and tibiae.	3 days	68th St. tunnel.	28–30	Few	2 hours	16	No	Six months later rupture of blood vessel at knee. Relieved by operation. (Ligation femoral artery?.)
113	44	1st	1898?	Pain in legs and arms.	1 day	Bridge in New York.	38	3–4	½ hour	2	No	
		2nd	1898?	Pain in legs and arms.	2 hours	Bridge in New York.	40	3–4	Short	2	No	
		3rd	1898?	Bled left ear; vertigo.	1 day	Bridge in New York.	42	?	Immediately	2	No	Slightly impaired hearing; otherwise well.
		4th	?	Pains in calves and shoulder.	Several hours	Cleveland tunnel.	30	?	?	?	No	
		5th	?	Same as fourth attack.	Several hours	Cleveland tunnel.	30	?	?	?	No	

114	48	One	1900	Bleeding nose and ears; pain in head; vertigo; mental confusion.	2 weeks	39th St. tunnel.	18–30	?	Onset 20 minutes after entrance; worse on exit	20 minutes.	No	Deafness and tinnitus right ear marked for 2 years. Now only slightly impaired hearing right ear. Slight analgesia face and neck. Claims memory impaired since attack. Bridge tender last four years.
115	46	One	1902	Pain right knee.	Severe 3 days; chronic stiffness and light pain	Cincinnati.	50	55	1½	6	No	Pain and stiffness right hip and knee. Increased knee and ankle jerks. Mason inspector for city.
116	47	Several	1898 to 1902	Several attacks pain right knee and shoulder; three attacks "chokes."	Maximum 24 hours	Cleveland tunnel.	?	?	?	?	No	Well. In compressed air last 25 years up to 50 lbs. No attacks except these in Cleveland.
117	45	One	1910	Tinnitus, bleeding nose and ears, pain in knees.	2 hours	St. Louis bridge.	49	25	Onset on entrance	Few minutes	?	Well. Not in compressed air since.
118	58	Many	1895 and 1905	Frequently "blocked" and bled from ears. Once pain in ears and neck one week.	Variable	Oak St. tunnel. Lawrence Ave. tunnel.	Variable	Variable	Onset on entrance	Generally 8	No	Hearing slightly impaired; occasional tinnitus.
119	40	1st	1893	Paresthesia and pain legs, abdomen and arms; tinnitus, bleeding nose and ears; unconscious 3 hours.	In bed 3 days; at home 3 weeks	68th St. tunnel.	33	?	Onset during work	1	No	Impaired hearing left ear. Occasional stiffness in calves.
		2nd	1893	Bleeding nose and ears; pain in legs.	2 days	68th St. tunnel. 68th St. tunnel.	?	?	Onset during work	?	No	
120	42	One	1895	Stinging sensation in legs; bleeding from ears and nose. Headache.	1 week	68th St. tunnel.	29	?	Onset during work	8	No	Total deafness left ear for 6 months after attack. Now only partial.
121	35	1st	1905	Bleeding from nose and ears; pain in knees.	3 days	Cleveland tunnel.	37	5	Immediately	8	No	Slightly impaired hearing.
		2nd	1905	Bleeding from ears; pain in knees and abdomen.	6 days	Cleveland tunnel.	37	Few	Immediately	2	No	
122	37	1st-2nd	1896	Pain in knees and elbows.	1 week	4 Mile tunnel.	?	?	Short	8?	No	Well.
		3rd	1898?	Legs paralyzed for 30 hours then pain in legs and abdomen.	1 week	68th St. tunnel.	20	?	Short	8?	No	
123	29	1st	1900?	Pain right knee, nosebleed, right tinnitus.	2 days	Tunnel in Chicago.	38?	1	1 hour	2	No	Impaired hearing righk ear. Right knee jere diminished. Lost nost in explosion in N. Y.
		2nd-3rd	1900?	Pain in right knee.	Few hours	Tunnel in Chicago.	?	1	1 hour	2	No	
12[illegible]	24	1st	1904	Pain left arm.	18 hours	Morgan City, La.	37½	Few	4 hours	1½	No	Well
		2nd	1904	Pain left shoulder and patella.	55 hours	Louisiana.	48	2	3 hours	45 minutes	No	

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125	22	1st	1909	Pain knees, elbows, wrists.	2 hours	Arkansas.	51	15	½ hour	1½	No	Left ear deaf. Otherwise well.
		2nd	1910	Numbness, weakness legs.	Few hours	Arkansas.	40	?	½ hour	?	No	
		3rd	1910	Right ear "blocked;" tinnitus.	Permanant deafness right ear	Arkansas.	?	?	Onset on entrance	?	No	
		4th	1910	Pain left knee.	4 days	East St. Louis bridge.	45	10–15	1 hour	2	Yes	
126	34	1st	1902	Pain swelling and weakness of right arm.	6 hours	St. Charles, Mo.	41	Few	10 hours	1½	No	Paralysis right deltoid.
		2nd	1907	Pain left hip.	36 hours	Morgan City, La.	33	2–2½	12 hours	1½	No	Constant dull pain in left hip since second attack.
127	45	1st	1890?	Pain left knee.	4 days	Memphis, Tenn.	49	20	Short	45 minutes	No	In compressed air work continuously for 28 yrs.
		2nd	?	Numbness both legs.	Few hours	Bellefontaine bridge, Mo.	40	?	1 hour	?	No	
		3rd	?	Pain left arm.	Few hours	Williamsburg bridge, N. Y.	?	?	?	?	?	Has bled from ears many times. Hearing impaired; otherwise well.
		4th	?	Pains in arms.	?	Metropolitan Life Bldg., N. Y.	36	?	?	?	?	
		5th	1900	Pain and swelling in precrudial region.	Swelling 6 months	Hudson tunnel.	42	20–25	?	3	No	
		Several		Paralysis of legs; pain in abdomen, "chokes."	?	Brooklyn tunnel.	?	?	?	?	Yes	
		Several	1906	Pain in abdomen.	Few hours	Clinton, Ia., bridge.	?	?	?	?	?	
			1910	Pain in knees.	Longest attack 1½ days	East St. Louis bridge.	?	?	?	?	?	
128	39	1st	1908?	"Blocked" in left ear; bleeding from left ear and nose. Tinnitus.	Left ear permanently deaf.	Traction bridge, St. Louis.	30	?	Onset on entrance	?	No	Also several light attacks of pain in arms and legs.
		2nd	1910	Both ears "blocked;" nose-bleed.	Ear discharge 3 weeks	St. Louis bridge.	?	?	Onset on entrance	?	No	Hearing very poor in both ears.
129	30	1st	1905	Pain in left arm; right tinnitus.	4 days	Canadian, Texas.	?	?	?	?	No	Hearing poor in both ears especially left. Tendon reflexes lost.
		2nd	1906	Pain in left knee.	4 days	Parker, Ariz.	38	Few	?	?	No	
		3rd	1910	Pain in left knee and ankle.	Few hours	St. Louis bridge.	38	?	6 hours	2	Yes	Intemperate.
130	26	1	1905	Pain left arm.	2 hours	New Jersey.	28	20	1 hour	4	No	Later in pressure of 51 lbs. at East St. Louis without trouble. Well.
131	22	1st	1910	Numbness from chest down; weakness of legs; pain in abdomen.	Few hours	Arkansas.	38	20	2 hours	3	No	Well.
		2nd	1910	Pain in legs and arms.	8 hours	East St. Louis bridge.	51	15–20	Immediately	1	Yes	
		3rd	1910	Pain in legs and arms.	2 hours	East St. Louis bridge.	35	12–14	20 minutes	3	Yes	

132	33	1st	1900?	Pain both thighs. Paralysis and numbness of both legs.	5 days	Nebraska.	36	18–20	Immediately	3	No	Legs a little weak since first attack.
		2nd	1906	Pain left arm.	3 days	Parker Ariz.	42	18–20	Immediately	1½	No	
		3rd	1906	Pain left arm.	12 hours	Clinton, Ia.	35	Slow	Immediately	3	No	
		4th	1910	Pain left arm.	2–3 hours	East St. Louis bridge.	51	20	1–2 hours	1	No	
		5th	1910	Pain left arm.	24 hours	East St. Louis bridge.	40	?	?	?	No	
133	24	15–20	?	Pain in arms and legs. "Blind staggers."	Few 20 minutes	Hudson tunnel, Hibbing, Minn.	? ?	? Very rapid	? 5 minutes	? In and out 9 times in ½ hour	? Yes	Well except occasional pains in left shoulder when away from compressed air.
134	30	One	1910	Pain in left thigh.	4 hours	St. Louis bridge.	38	8–10	2–3 hours	2	No	Hearing impaired in left ear.
135	27	1st	1905	Pain in both legs.	2 days	Canadian, Texas.	52	10 minutes	Few minutes	1	No	
		2nd	1909	Pain in abdomen, groins and genitals; swelling of scrotum.	1 hour	Arkansas.	46	"Fairly slow"	Few minutes	1½	No	Well.
		3rd	1910	Numbness and paralysis of left leg.	Few hours	St. Louis bridge.	40	"Slow"	1–2 hours	2	Yes	
136	29	1st	1910	Numbness and paralysis right arm, followed by pain.	Few hours Pain 2 days	East St. Louis bridge.	45	?	10 minutes	2 or 3	Yes	Well.
		2nd	1910	Pain right knee, followed by paralysis of right leg.	5 hours	East St. Louis bridge.	45	?	3½ hours	2	Yes	
137	35	Several	1906	Pain in legs, arms, shoulders, about 20 times.	Longest 3 days	Canadian, Texas.	?	?	?	?	?	Once "blocked" and bled from right ear in St. Louis. Now well.
138	29	One	1906	Pain in knees and elbows paralysis right leg.	4 days weak 1 month	Texas.	47	10 or less	Few minutes	?	No	Well.
139	37	1st	1898	Pain in knees.	1 day	New York.	30	?	?	?	No	Right ear deaf.
		2nd	1909	Pain in back, paralysis legs, retention of urine.	2 days, weak 2 weeks	Arkansas.	4-	15	Few minutes	45 minutes	No	
		3rd	1909	Tight sensation in right ear; impaired hearing.	Permanent	St. Louis bridge.	?	?	Few minutes	?	No	
140	24	1st	1907 or 1908	Pain left arm.	12 hours ?	St. Louis bridge.	25	15	Short time	3	No	Well.
		2nd	1908	Pain in legs.	?2 hours ?	St. Louis bridge.	40	?	?	?	No	
		7 or 8	1910	Pain in legs.	Few hours	St Louis bridge.	Max. 50?	?	?	Variable	Yes	
		1	1910	Bleeding ears and nose, tinnitus, headache, vertigo.	1 hour	St. Louis bridge.	?	?	During decompression	?	No	
141	23	1st	1910	Pain left knee.	12 hours	East St. Louis bridge.	35	5–6	3 hours	?	Yes	Impaired hearing left ear.
		2nd	1910	Pain left knee and arms.	12 hours	East St. Louis bridge.	45	15	1 hour	2	No	Has been "blocked" twice.
142	30	1st	1907	Pain in shoulders, elbows, knees.	1 day	Morgan City, La.	47	15	10 minutes	2	No	Well.
		2nd	1908	Pain left wrist.	Few hours	Louisiana.	45	?	?	?		
143	36	1st	1910	Pain right wrist and right leg.	1 hour	East St. Louis bridge.	40+	15	20 minutes	1½	Yes	Suspicious signs of cerebro-spinal syphilis.
		2nd	1910	Pain left wrist.	1 hour	East St. Louis bridge.	40+	15	1 hour	1½	No	Chancre 3 years ago.

TABLE OF CASES—Continued.

Case No.	Present Age	Number of Attacks	Year	Chief Symptoms	Duration of Attack	Place	Pressure above Normal in pounds	Length of Decompression in Minutes	Interval before Onset	Length of stay in Compressed Air	Treated by Decompression	Present Condition
144	33	1st	1907	Pain right forearm and elbow.	Few hours	Louisiana.	38–40	15	?	?	No	Well.
		2nd	?	Pain left leg.	Few hours	Arkansas.	25	?	?	?	No	
		3rd	1910	Pain left arm.	Few hours	East St. Louis bridge.	50	20	10 minutes	1	Yes	
145	21	1st	1907	Pain and swelling right knee.	2 days	Louisiana.	49	15	10 minutes	45 minutes	No	
		2nd	?	Pain in arms.	24 hours	Arizona.	37	20	Immediately	2	No	Well.
		3rd	1909	Pain right elbow.	8 hours	Arkansas.	37	16–17	?	?	No	
		4th	1909	Pain right elbow.	3 days	Arkansas.	37	16–17	?	?	No	
		5th	1910	Pain left knee.	7 hours	East St. Louis bridge.	36	15	Immediately	1½	Yes	
146	29	1st	1908 or 1909	Pain and paralysis, legs.	3 hours	St. Louis bridge.	43	5 minutes	2–3 hours	1	Yes	
		2nd	1909	Pain right wrist.	1½ hours	St. Louis bridge.	37	?	?	?	No	Well.
		3rd	1910	Pain left shoulder.	13 hours	St. Louis bridge.	43	6	Several hours	?	No	Well.
		4th	1910	Pain forehead; blurred vision.	Few hours	St. Louis bridge.	30	?	Short	?	Yes	
147	36	1st	1905	Paralysis legs; retention of urine.	8 days	Texas.	53	5	15 minutes	1½	No	Slight weakness right arm since last attack. Otherwise well.
		2nd	1909	Pain right shoulder.	2 days	Arkansas.	40	Few	Short	12	No	
		3rd	1910	Pain knees; paralysis legs.	18 hours	East St. Louis bridge.	51½	3½	5 hours	7	Yes	
		4th	1910	Pain right shoulder.	17 hours	East St. Louis bridge.	45	3–5	½ hour	Several	Yes	
148	26	One	1910	Pain right arm.	1 week	East St. Louis bridge.	49	?	15 minutes	?	Yes	Six or seven lighter similar attacks. Well.
149	45	1st	1890?	Pain arms and legs.	36 hours	Cairo, Ill.	36	?	?	4	Yes	This year attack of ascites. Leg reflexes increased. Now well.
		2nd		Pain in back.	24 hours	Memphis, Tenn.	38½	Few	Immediately	?	No	
		3rd		Pain left arm and right leg.	36 hours	Bellefontaine, Mo., bridge.	?	?	?	?	No	
		4th	1893	Paralysis legs; retention of urine.	5 weeks	Jefferson City, Mo.	34½	?	Onset during work	?	No	
150	26	1st	1907	Pain left knee.	2 days	Louisiana.	51	20	20	1	No	"Blocked" several times.
		2nd	1910	Pain left knee.	Few hours	Arkansas.	28	25	?	3	No	Impaired hearing right ear.
		3rd	1910	Pain left shoulder.	48 hours	St. Louis bridge.	38	?	?	2	Yes	
151	29	1st	1909	Pain right knee.	12 hours	Arkansas.	47	7	?	45	No	Well.
		2nd	1910	Pain left knee.	24 hours	East St. Louis bridge.	49	15	½ hour	1	No	
		3rd	1910	Pain left shoulder.	3 hours	East St. Louis bridge.	37	15	10 minutes	3	No	
152	27	One	1910	Left arm and leg numb and weak.	1 hour	East St. Louis bridge	47	?	7 hours?	Previous shift 45 minutes	Yes	Well.

153	44	1st	1899	Pain in left arm.	22 hours	Arkansas.	?	?	Short	?	No	
		2nd	1909	Pain legs and elbows.	24 hours	Louisiana.	51	15	½ hour	1	No	Also "blocked" several times.
		3rd	1910	Pain left leg.	10 hours	Arkansas.	37	?	?	?	No	
		4th	1910	Pain left leg.	10 hours	East St. Louis bridge.	50	20	½ hour	1?	Yes	Left ear deaf.
		5th	1910	Pain both arms.	6 hours	East St. Louis bridge.	47	20	Short	2	Yes	
		6th	1910	Pain right leg.	Few hours	East St. Louis bridge.	24	?	?	?	No	
154	22	1st	1907	Pain left arm and leg.	24 hours	Mobridge, S. D.	44	20	10 minutes	1	No	Well.
		2nd	1908	Paralysis legs, retention of urine.	1 hour	Gwinn, Mich.	47	10	½ hour	40 minutes	Yes	
155	24	1st	1907	Pain left knee.	2 days	Arkansas.	22	7	10 minutes	8	No	Left ear deaf. Signs of spinal cord lesion.
		2nd	1908	Pain in abdomen, paralysis both legs, retention of urine.	2 weeks	East St. Louis bridge.	28	10	Short	3	No	
		3rd	1908	Pain in abdomen, "blind staggers."	10 days	East St. Louis bridge.	30	10–12	Immediately	3	No	
		4th	1910	Pain left hip.	1 day	East St. Louis bridge.	40	15	?	2	Yes	
156	29	1st	1910	"Blocked" pain in ears.		East St. Louis bridge.			Onset on entrance			
		2nd	1910	Pain right arm.	5 hours	East St. Louis bridge.	52	20–25	45 minutes	2	No	Impaired hearing right ear.
157	24	1st	1908	Paralysis and pain in legs.	2 days	Arkansas.	39	15	45 minutes	2	No	Well
		2nd	1910	Pain left arm.	2 days	East St. Louis bridge.	49	20	½ hour	1	Yes	
158	29	One	1908	Pain right arm and right leg.	5 hours	Arkansas.	44	16–18	1 hour	1	No	
159	39	1st	1892	Pain in legs.	5 hours	Louisville, Ky.	38	5+	12 hours	6	No	Many attacks of "bends"
		2nd	?	"Blind staggers."	8 days	New York.	36	5–10	2 hours	6	No	
		3rd	1905	"Blocked;" later purulent otitis media.		New York.	?		Onset on entrance			Impaired hearing.
160	33	1st	1898?	Bleeding right ear tinnitus, deafness.	1 week	Tunnel in Chicago.	18		Onset on entrance			Impaired hearing.
		2nd	1901	Pain in legs.	18 hours	Cleveland.	37	Few	1 hour	8	No	
		3rd	1901	Pain in legs.	Sev'l hours	Cleveland.	27	Few	?	8	Yes	
		4th	1901	Pain in legs.	24 hours	Cleveland.	27	Few	1 hour	8	No	
		5th	1907	Pain in legs.	1 hour	Clinton, Ia.	27	Few	45 minutes	4	Yes	
161	47	1st	1895	Tinnitus, pain in knees.	2 days	Oak St. tunnel.	?	?	Few hours	8?	No	Imapired hearing.
		2nd	1895	Same symptoms deafness.	Chronic partial deafness	Oak St. tunnel.	36–38	?	Few hours	8	No	

Illustrative Cases.

Among those recorded in the table, the following will be cited as illustrations. Full records of all cases are in the possession of the writer:

Case 8. Severe type with permanent crippling. Aged 54 years. He worked under compressed air on the Four Mile tunnel, Chicago, from 1890 to 1893, and had charge of the bricklaying. He had the "bends" three times. The first time after an eight-hour shift he came out from pressure of 22 pounds in two or three minutes, although he had been advised by the engineer in charge to spend ten minutes, but this precaution was seldom taken. In half an hour he was taken with severe pain in the knees, shoulders and wrists, became dizzy, fell down on the street, and was picked up by a policeman, who thought he was drunk until informed by other workmen. He returned to work the next day. The second attack was similar, starting with pain in the knees; then he was dizzy and slightly dazed. He returned to work the next day. The third attack came on one-half hour, after less than five minutes' decompression, after an eight-hour shift in pressure of 33 to 35 pounds. He was taken with dizziness and pain in the knees. Was taken home, stayed in bed for about thirty-six hours, was not clear mentally, sat up in bed and "mumbled." He returned to work in a week, but the legs were weak and aching and the back was painful on stooping. No sphincter disturbance at first, but in a few weeks developed precipitate urination, which grew worse and became permanent. He had to give up work and was a patient in the Cook County Hospital from February to May, 1895. His case then seemed to have attracted considerable attention. He has never recovered, has suffered much pain, and walks very poorly. Has not been able to work at his trade since then, and has been idle most of the time, but at present has an easy position as night watchman. He was in perfect health before working in compressed air. On examination there is found opacity of the left cornea. The right pupil reacts to light. Hearing in the right ear is defective, the watch only being heard on contact. In the left ear it is heard at three inches. He cannot get the right heel down to the floor except when the left heel is raised. The left knee jerk is considerably exaggerated, the right about normal. Both ankle jerks diminished, the left more so. Arm reflexes normal. Sensation normal. While the man is said to have been a heavy drinker, the mode of onset and the physical findings make it certain that he is suffering from typical caisson disease.

Case 31. Permanent Deafness. Aged 53 years. Twenty-two years ago worked on Four Mile tunnel, Chicago, as a bricklayer. One night he came home feeling dizzy; at 2 a. m. when wife spoke to him he was deaf. He staid in bed for three days on account of dizziness. No bleeding or discharge from ears. The deafness persisted and he consulted many physicians, among them the late Dr. Holmes, who said both ear-drums had ruptured. He had no "bends." His wife says that his memory has grown poor since the injury. He could no longer secure work as a bricklayer, on account of his deafness, and now does any kind of cheap labor he can pick up. The right ear is totally deaf; on the left he hears when shouted to at close range. Without his wife I should not have been able to converse with him. Severe tinnitus has been present ever since the

onset of deafness. Now he is accustomed to it, but it annoyed him much at first.

Case 47. Permanent Joint Disease of the Type of Arthritis Deformans, coming on after working two shifts. Aged 67 years. Carpenter. Twenty years ago he worked on the Four Mile tunnel in Chicago without trouble. Eleven years ago he did some carpenter work in the Oak Street tunnel and worked two eight-hour shifts under pressure of about thirty pounds, from which he came out rapidly. On the way home he got pains in the legs, which became extremely severe and lasted all night. He says that he was blue all over the body and that the physician could not feel his pulse. The blueness disappeared after rubbing the skin. He went to work in four days, but the legs were weak, especially the right one. He has walked lame ever since on account of pain, which is chiefly felt in the right groin, and especially comes on when he starts walking. A year after the onset he saw the late Dr. Christian Fenger, who put on an extension apparatus for ten weeks. Then he felt worse and had to use crutches for a year. He has not worked since this time. He never had any rheumatism, and was in perfect health before this occurrence. The knee jerks are brisk, the ankle jerks normal. Sensation and plantar reflex in the right leg normal. He had no sphincter disturbance, but now has to get up nights to urinate. There is an apparent lengthening of the right leg, which he says has been present ever since the extension apparatus was used.

Dr. Hollis E. Potter took an X-ray picture of the right hip and reports the findings as follows: "All changes are compatible with an arthritis deformans of the hip joint, namely: The head of the femur is flattened and mushroomed; the neck of the femur appears shorter and wider; cartilaginous space decreased; osteophytes laid down at edge of cartilage, acetabulum and head of femur."

The following two cases were rather severe, but nevertheless the two men are doing active work, and in the first one no sign of permanent injury exists:

Case 147. Aged 36 years; foreman. Seen at St. Louis. Has worked in compressed air for ten years, much of the time as foreman or superintendent; has made his own rules, and has stayed much longer in and come out more quickly from the compressed air than the ordinary laborers are permitted to do.

The first attack occurred at Canadian, Texas, in 1905. He staid in a caisson which had sunk for 1½ hours at pressure of 53 pounds, and came out in about five minutes. Then stood out in the cold air for a while, and after fifteen minutes suddenly became paralyzed from the waist down. He had no pain, could not move the legs for eight days, had to be catheterized for ten days, and required enemas to move the bowels. He then improved rapidly, but had severe pain in the knees and ankles for four days after recovering from the paralysis. He had full control of the bladder after the retention ceased, but there was burning on micturition for some time. The catheter had not been boiled and had been passed by a "sand-hog." The next attack occurred in Arkansas one

year ago, after he had spent 12 consecutive hours in a pressure of 40 pounds. He came out as rapidly as the valve would permit, and had severe pain in the right shoulder for two days. He had no trouble when working on the Traction bridge at St. Louis, but has had two attacks while working on the new bridge since last February. The first one occurred on the Illinois side last September. He spent seven hours at a pressure of 51½ pounds and came out in 3½ minutes, while the time prescribed for the men was 35 to 40 minutes. Five hours later, when in bed, he was taken with slight pain in the knees, and one hour afterwards became paralyzed from the waist down. He was placed in the Hospital lock forty-five minutes after the onset of paralysis, and movement returned in thirty-five minutes. He staid in the Hospital lock for about eighteen hours, and then was perfectly well and returned to work. The second attack also occurred on the Illinois side, on October 25th. He staid in a pressure of 45 pounds for several hours, came out in three to five minutes, when half an hour later was taken with pain in the right shoulder. He used hot applications without any benefit, and two hours later he went to the Hospital lock, where he remained for seventeen hours, during which he had no relief at all, and after coming out he was worse than before. The arm is still weak and hurts a little. There was no swelling. Reflexes and sensation in both arms normal. Knee jerks brisk.

Case 155. Aged 24 years. Seen at St. Louis. Beginning at St. Charles, Mo., in 1903, he has been constantly engaged in compressed air work. The first attack occurred in Arkansas three years ago. He was working on a railway bridge and on the last day of the work (shifts 8 hours, out ½ hour for lunch) came out from pressure of 22 pounds in seven minutes, and ten minutes later was taken with severe pain in the left knee. He was given whiskey and a hypodermic injection, and went to sleep. The next day the knee was sore when moved, and he was entirely well in a few days. The next attack occurred when working on the Traction bridge at St. Louis, 2½ years ago. He was then working two daily shifts of three hours each, at pressure of 28 pounds. After coming out from the first half, in about ten minutes he was taken with pain across the abdomen, and "knots" formed in the abdominal and chest walls. He took a bath and was rubbed, then the pain left, but both legs became paralyzed. The paralysis lasted only two hours, but he had to be catheterized every day for two weeks, during which he was in a hospital at Granite City, Ill. The legs have been a little numb ever since, and easily "fall asleep." After the retention of urine ceased there was dribbling for six or seven months. No difficulty with the bowels. He returned to work in a month and worked two 3-hour shifts at pressure of 30 pounds in one day. After coming out from the second half, in ten or twelve minutes he was immediately taken with pain in the abdomen. Took a bath and was then suddenly taken with extreme dizziness, tinnitus, and nausea. He could not see plainly; everything seemed to whirl around. He did not vomit until a physician gave him medicine which he thinks was an emetic. He was in the hospital for ten days, could walk after four days, but some dizziness remained for two months. Tinnitus and complete deafness were present the first three days, and hearing has never been normal since. Then he had a couple of attacks of "bends" while working on two bridges in Arkansas. The first one was slight and affected the hips; the second one was rather severe, affected the left arm,

and he did not fully recover for a week. Since last February he has worked on the bridge at St. Louis, and in April, while on the Illinois side, working two daily 2-hour shifts at pressure of 40 pounds, he had an attack. Decompression lasted fifteen minutes, following which he was taken with pain in the left hip, which lasted all night, and finally was relieved in the Hospital lock, but he had to go in and out four times. Aside from these definite attacks he has frequently had some burning in the skin of the abdomen and of the left arm after coming out. This has occurred as a regular thing when the pressure was high. He has also frequently been dizzy for about ten minutes after coming out.

Watch heard in right ear at three feet; in the left ear not heard on contact; but C 2 tuning fork is heard. Both knee and ankle jerks are exaggerated, and there is reduced pain sensation in the left leg.

VII.

Suggestions for Eventual Legislation. Is a Special Law, Laying Down Specific Rules for This Dangerous Work, Desirable?

The following reply to an inquiry by Heller, Mager and Schrötter, received from the corps of engineers of the U. S. Army, dated January 20, 1896, indicates fairly well the prevalent attitude in this country, where special protective legislation is looked at more or less askance, and often denounced as "paternalism":

"The general government has not established any rules governing this class of work, and any regulations that might be adopted would be under state or local authorities. The main reliance against any violation of known precautions in work of this class is the common law principle that contractors and corporations are liable for any damage done to individuals if they can show culpable neglect. For this reason all contractors adopt such regulations and rules as are proven by experience to be essential to protect themselves from suits for damages being brought against them. Another reason, aside from the humanitarian one of preserving life, is the fact that if a work gains the reputation of being dangerous to health or life, no help can be procured except at very high rates of pay." (Signed by H. W. Kuehnle, Assistant Engineer.)

As this investigation has shown, such regulations and rules are not in general evidence in this part of the country. Men are not carefully selected so as to exclude those physically unfit. Largely through pressure brought by the workingmen, the hours of work are generaly fairly suitable, but the all-important rigid regulation of the duration and manner of decompression is not in evidence, largely because the men themselves object to staying a long time in the lock. The advantage of having a "hospital lock" in readiness where high pressure is used, is becoming recognized also in the West, largely through the good example set by the New York Foundation Company. Any set of rules proposed should include the following features:

1. Medical inspection of candidates for work; foremen and lock-tenders to be forbidden to admit men not possessed of a medical certificate. Such inspection to be repeated at intervals, the frequency of which should be proportionate to the amount of pressure used.

2. Regulations of length of shifts. The periods allowed in the New York law (see above, Table 5) are acceptable, providing the decompression is strictly regulated.

3. Regulation of length of decompression, giving as alternatives the uniform method of the New York law or the "stage decompression" adopted by the British Admiralty.

4. Provisions for keeping the air in the lock warm during decompression.

5. Provision for a warm place for changing clothes immediately after coming out from lock.

6. A reliable gauge for the registration of pressure, and a reliable clock, both in plain view of the men in the lock, should be provided.

7. When pressure exceeding 25 pounds is to be used, no person should be permitted to act as a lock-tender who is not possessed of a certificate issued by the State Factory Inspector on the presentation of evidence that he is competent and acquainted with the existing laws governing compressed air work. Interference on the part of anyone with the carrying out of the regulations of this act by the lock-tender should be punishable. State inspectors should make frequent visits and all serious cases of illness should be reported to them.

8. Whenever the pressure used exceeds 25 pounds, a "hospital lock" in charge of a licensed lock-tender should be in readiness within a short prescribed distance.

9. An abundant supply of fresh air should always be present in the caissons. Whenever necessary, ventilating pipes should be provided.

VIII.

The New York Law.[1]

Section 134-a. Hours of Labor. All work in the prosecution of which tunnels, caissons or other apparatus or means in which compressed air is employed are used shall be conducted subject to the following restrictions and regulations: When the air pressure in any compartment, caisson, tunnel or place in which men are employed is greater than normal and does not exceed twenty-eight pounds to the square inch, no employee shall be permitted to work or remain therein more than eight hours in any twenty-four hours and shall only be permitted to work under such air pressure provided he shall during such period return to the open air for an interval of at least thirty consecutive minutes, which

[1] Cited from Ninth Annual Report of the Commissioner of Labor of the State of New York. Appendix VI. Laws relating to labor in force October 1, 1909. Compiled by the Bureau of Labor Statistics.

interval his employer shall provide for. When the air pressure in any such compartment, caisson, tunnel or place shall exceed twenty-eight pounds to the square inch, and shall not equal thirty-six pounds to the square inch, no employee shall be permitted to work or remain therein more than six hours, such six hours to be divided into two periods of three hours each, with an interval of at least one hour between each such period. When the air pressure in any such compartment, caisson, tunnel or place shall equal thirty-six pounds to the square inch and shall not equal forty-two pounds to the square inch, no employee shall be permitted to work or remain therein more than four hours in any twenty-four hours, such four hours to be divided into periods of not more than two hours each, with an interval of at least two hours between each such period; when the air pressure in any such compartment, caisson, tunnel or place shall equal forty-two pounds to the square inch and shall not equal forty-six pounds to the square inch, no employee shall be permitted to work or remain therein more than three hours in any twenty-four hours, such three hours to be divided into periods of not more than ninety minutes each, with an interval of at least three hours between each such period; when the air pressure in any such compartment, caisson, tunnel, or place shall equal forty-six pounds to the square inch and shall not equal fifty pounds to the square inch, no employee shall be permitted to work or remain therein more than two hours in any twenty-four hours, such two hours to be divided into periods of one hour each, with an interval of not less than four hours between each such period; no employee shall be permitted to work in any compartment, caisson, tunnel or place where the pressure shall exceed fifty pounds to the square inch, except in case of emergency. No person employed in work in compressed air shall be permitted by his employer or by the person in charge of said work to pass from the lock in which the work is being done to atmosphere of normal pressure, without passing through an intermediate lock or stage of decompression, which said decompression shall be at the rate of three pounds to every two minutes unless the pressure shall be over thirty-six pounds, in which event the decompression shall be at the rate of one pound per minute. Instruments shall be fitted in all caissons and air locks showing the actual pressure prevailing. [Added by L. 1909, ch. 291.]

Section 134-b. Medical Attendance and Regulations. Any person or corporation carrying on any work in the prosecution of which tunnels, caissons, or other apparatus or means in which compressed air is employed are used shall employ and keep in employment during the prosecution of such work, at the place where it is being carried on, one or more duly qualified persons to act as medical officer or officers, who shall be in attendance at all times while such work is in progress and whose duty it shall be to administer and strictly enforce the following:

(a) No person shall be permitted to work in compressed air until after he shall have been examined by such medical officer and reported by such officer to the person in charge thereof as found to be qualified, physically, to engage in such work.

(b) In the event of the absence from work, by an employee for three or more successive days for any cause, he shall not resume work

until he shall have been re-examined by the medical officer and his physical condition reported, as hitherto provided, to be such as to permit him to work in compressed air.

(c) No person known to be addicted to the excessive use of intoxicants shall be permitted to work in compressed air.

(d) No person not having previously worked in compressed air shall be permitted, during the first twenty-four hours of his employment, to work for longer than one-half of a period as provided in section 134a, and after so working shall be re-examined and not permitted to work unless his physical condition be reported by the medical officer, as heretofore provided, to be such as to qualify him for such work.

(e) After a person has been employed continuously in compressed air for a period of three months, he shall be re-examined by the medical officer, and he shall not be allowed, permitted or compelled to work until such examination has been made and he has been reported, as heretofore provided, as physically qualified to engage in compressed air work.

(f) The said medical officer shall at all times keep a complete and full record of examinations made by him, which record shall contain dates on which examinations were made and a clear and full description of the person examined, his age and physical condition at the time examined, also the statement as to the time such person has been engaged in like employment.

(g) Properly heated, lighted and ventilated dressing rooms shall be provided for all employees in compressed air, which shall contain lockers and benches and shall be open and accessible to the men during the intermission between shifts. Such rooms shall be provided with baths, with hot and cold water service and a proper and sanitary toilet.

(h) A medical lock shall be established and maintained in connection with all work in compressed air as herein provided. Such lock shall be kept properly heated, lighted and ventilated and shall contain proper medical and surgical equipment. Such lock shall be in charge of the medical officer. [Added by L. 1909, ch. 291.]

Section 134-c. Penalties. Every person who, or corporation which, shall violate or fail to comply with any of the foregoing provisions shall be guilty of a misdemeanor which shall be punishable by a fine of not less than two hundred and fifty dollars or imprisonment for one year, or both. [Added by L. 1909, ch. 291.]

Section 135. Enforcement of Article. The commissioner of labor may serve a written notice upon the owner, agent, manager or lessee of a mine or tunnel requiring him to comply with the specified provision of this article. The commissioner of labor shall begin an action in the supreme court to enforce compliance with such provision; and upon such

notice as the court directs an order may be granted, restraining the working of such mine or tunnel during such times as may be therein specified.

Formerly L. 1897, ch. 415, Sec. 128, as am'd by L. 1907, ch. 399, Sec. 1.

Section 139. Admission of Inspectors to Mines and Tunnels. The owner, agent, manager or lessee of a mine or tunnel, at any time, either day or night, shall admit to such mine or tunnel, or any building used in the operation thereof, the commissioner of labor or any qualified person duly authorized by him, for the purpose of making the examinations and inspections necessary for the enforcement of this article, and shall render any necessary assistance for such inspections.

Formerly L. 1897, ch. 415, Sec. 129, as am'd by L. 1907, ch. 399, Sec. 1.

APPENDIX.

Laws in Other Countries Governing Compressed Air Work.

Holland. Largely as the result of Schrötter's writings, according to E. Roth,[1] the laws of May 22, 1905, and Jan. 26, 1907, were adopted. Paragraph 1 gives rules for appliances in places of work, ventilation, presence of hospital-lock, provision of a room for rest after coming out of lock, medical examination of the workers, duration of compression and decompression, duration of shifts. The rules were amplified by a Royal Decree of June 27, 1905. The duration of compression should be at least one-half minute per one-tenth atmosphere (1½ pounds). Decompression from pressure less than one-half atmosphere (7½ pounds) should be at a rate not exceeding one minute per one-tenth atmosphere. From a pressure between one-half and 1½ atmospheres (22 pounds) the time should be five minutes plus 1½ minutes for each one-tenth atmosphere above one-half atmosphere. For work in pressure of three atmospheres (45 pounds) or more, men must be selected who are between twenty and thirty-five years of age, and who have no disease of the organs of circulation, respiration and hearing, or of the nervous system.

France. According to Roth (l. c.), the decree of Dec. 15, 1905, prescribes that a medical certificate is necessary in order to permit a man to do work in compressed air. Re-examination is required after the first two weeks, then every month. At least 60 cubic meters of air are required for each man every hour. There are detailed regulations for the time of compression and decompression and equipment. Men under 18 years not admitted to compressed air work.

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[1] Kompendium der Gewerbekrankheiten, 2nd Edition, Berlin, 1909, p. 274.

5. Reports of Drs. Geo. E. Shambaugh and G. W. Boot on Occupation Deafness.

Occupation may lead to injury to the organ of hearing in the following ways:

1. By mechanical or chemical irritation of the external ear.

2. By causing catarrhal condition of the nose and throat, which lead to middle ear catarrh.

3. By exposure to variations in atmospheric pressure.

4. By exposure to explosions.

5. By exposure to noises.

1. Workers in dust laden atmosphere, as chimney sweeps millers, bakers, stokers, laborers in coal, cement workers, jute weavers, etc., may have particles from the air accumulate in the external canal, where aside from obstruction they may set up inflammatory conditions, such as eczema. Workers in chemical industries, such as varnish, zinc, chromium and arsenic, are subject to eczema and furunculosis of the external ear.

2. These same occupations lead to ear diseases also by first causing catarrh of the nasal mucous membranes, either from mechanical or chemical irritation of these membranes. This often leads to catarrhal involvement of the middle ear with accompanying defective hearing. Ear trouble arises in the same way from meteorological influences among coachmen, miners, stokers, soldiers, sailors, postmen, engineers, firemen, etc.

3. Variation in atmospheric pressure, such as experienced by balloonists, divers, caisson workers, frequently lead to injuries to the middle ear, such as a rupture of the drum membrane or a hemorrhage into the tympanum or drum membrane.

Among tunnel workers in compressed air Erdman [1] found vertigo to occur in 7% of the 1,419 cases which he examined. Vomiting occurred in 2% of the cases. Nystagmus and deafness rarely occurred.

Philip [2] found that rupture of the membrana tympani occurred both during compression and decompression of caisson workers, and that hemorrhage into the membrana tympani occurred.

[1] Sach. Archiv. f. Ohrenhkde., LXV., p. 14, *et seq.*
[2] Sach. Archiv. f. Ohrenhkde., LXV., p. 14, *et seq.*

These injuries of the middle ear are most apt to occur when the pressure runs up to 3 atmospheres, if the mucous membrane lining the Eustachian tube is swollen. Caisson workers and divers in depths of from 2 to 4 metres often suffer. Workers in great depths often suffer from middle ear affections.

Habermann [3] examined a number of workers under compressed air whose ages ran from 19 to 50 years and found:

Eleven cases had hyperemia of the membrana tympani or hemorrhage in the membrana tympani.

Two cases had hemorrhage into the cavity of the middle ear.

Three cases had inflammation of the membrana tympani.

One case had suppuration of the middle ear.

Gas embolism occurs in the internal ear in caisson workers. Continuous more or less loud subjective noises are apt to occur.

Such labyrinthine symtoms as total deafness, pallor, nausea and vomiting, and syncope occur in caisson workers, and at times are no doubt due to the hemorrhages that occur into the semi-circular canals, the cochlea (generally the scala tympani) and into the trunk of the auditory nerve. In certain cases the blood may be absorbed, but it is often followed by inflammation and atrophy of the organ of Corti and the formation of fibrous tissue.

4. Explosions, particularly of gas, dynamite, cannon, etc., frequently lead to deafness, due to injury to the internal ear. Temporary deafness may also occur as the result of rupture of the drum membrane.

5. It has been found that exposure to noise has a bad effect on hearing, particularly if the noise be loud and continued over a long time and in a confined place. This is particularly noticeable in boiler makers, locomotive engineers, artillerymen, spinners and weavers of jute, riveters, telegraph operators, etc. Thus [1]:

Of 74 locomotive engineers four had a combined middle ear and labyrinthine affection; 16 had double slight labyrinthine deafness.

Of 154 railway employers 6% were so deaf that continuance in the service was not advisable [2].

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[3] Habermann. Archiv. f. Ohrenhkde., XXX, 1, et seq.

[1] Erdman. Jour. of the Am. Med. Assn., 1907, XLIX., pp. 1665-1670.

[2] Philip. Ann. d. mal. de l'oreille, du larynx, etc. Par. 1907, XXXIII, pt. 2, pp. 140-158.

Of 115 firemen two had otitis media simplex combined with labyrinthine disturbance; 25 had labyrinthine affection of light grade; 12 had labyrinthine affection of high grade [3].

Of 106 engineers 10 had light labyrinthine affections; seven had mild labyrinthine affection; two had one-sided labyrinthine affections; 24 had high-grade labyrinthine affections; 11 had combined middle ear and labyrinthine disease.

Twenty-five per cent of firemen had labyrinthine affections

Ten per cent of firemen had severe labyrinthine affections.

Of 55 engineers over forty-five years of age 7% were normal; 47% had middle-grade disturbance of the labyrinth; 43% had high-grade disturbance of the labyrinth [1].

In the above railroad men subjective noises and dizziness were practically absent.

Engines fired with oil make a great deal of noise [2]. The conductor's signals could not be heard on the engine. After a trip of eight hours the auditory acuity of the engineer and fireman were lowered one-third, but was regained during a 15-hour rest. The noise of the burning petroleum, the whistle and the noise of the Westinghouse brake were the most important factors.

Fourteen per cent of the employees of the Southern Pacific R. R. have imperfect hearing, according to Minot [3].

"Slight deafness is widespread among jute operatives, but other textile workers may be affected in a similar degree. The excessive noise of the weaving looms and the persistent loud hum of the spinning frames presumably account for much of this. The looms, owing to their large size and weight and speed of the shuttles, are particularly noisy [4].

"Artisans who are exposed to such loud noises as are made in hammering rivets suffer from deafness. Boilermakers and riveters become deaf at an early age." [5]

Intense noises cause deafness, depending upon the age and time the occupation has been followed. The deafness is bilateral, the ear nearer the source of the noise being the one most affected. Subjective noises

[3] Sach. Archiv. f. Ohrenhkde., LXV., p. 14, *et seq.*
[1] Sach. Archiv. f. Ohrenhkde., LXV., p. 14, *et seq.*
[2] Costiniu. Bull. de laryngol. et rhinol. Par., 1904, VII., pp. 301-307.
[3] Minor. Internat. Jour. of Surgery, 1908, XXI., p. 359.
[4] Oliver. Dangerous Trades., p. 660.
[5] Oliver. Dangerous Trades, p. 660.

are present in about half the cases. Dizziness is occasionally present. The duration of hearing for high tones is shortened, some of the high tones being lost.

Arlidge [1] says that the most marked result of the boilermaker's occupation is the production of deafness. He found similar types of deafness occurring among riveters, artillerymen and workmen in engineering shops. "Boilermakers and riveters become deaf at an early age, while their comrades engaged in other kinds of work in the same shipyard do not suffer. Several young boilermakers whom I examined stated that they lost their hearing at an early age. The infirmity dated back to their ''prentice days,' when, as boys, they were sent into the boilers to catch the rivets and were subject to the intense hammering noise inside the cylinder. . . . . There is nothing I know that will prevent boilermaker's deafness short of substitution of machine for hand riveting, and once deafness is established there is no reliable cure for it." [2]

It has long been known that the defects in hearing arising from exposure to sound were the result of injury to the nerve of hearing. This conclusion was based on certain clinical tests which serve to differentiate quite clearly between defects in hearing arising from injury to the nerve and those that are dependent on some interference with the apparatus that conducts the sound impulses into the labyrinth where the nerve endings are located. Quite recently experiments on animals exposed to sounds have demonstrated just what these injuries to the nerve of hearing are.

It has long been known also that the noise associated with certain occupations, as those pointed out above, was capable of producing defects in hearing, while other noises did not. Experiments on animals have demonstrated just what the character of the noises are which produce changes in the nerve of hearing. Clinically it is known that the volume of sound to which the individual may be exposed appears to be of little importance. For example, the noisiest department in the harvester works is the department where binder twine is manufactured. Here the volume of sound is very great, yet in an examination of a series of persons who had worked continuously in this department for a number of years, some as many as 15 to 18 years, we detected none where there was defective hearing that could be attributed to the nerve of hearing.

Animal experiments show that low-pitched sounds are apparently incapable of producing injury to the nerve, no matter what the volume of these sounds may be. This is of great practical importance, since even in the noisiest factories the sounds are usually made up of tones in the lower register of the scale. These animal experiments have shown that the shrill, high-pitched tones are the ones which most readily result in injury to the nerve of hearing. Furthermore, it has been demonstrated in these experiments that the injury produced by tones of a certain pitch are different from the injuries resulting from tones of another

[1] Arlidge. The Diseases of Occupation, pp. 191 and 548.
[2] Oliver. Dangerous Trades, pp. 563 and 752.

pitch. Presumably the defect in hearing resulting from over stimulation by the tones of a certain pitch may not, at least for some time, affect the hearing for tones in a different part of the tone scale. Clinically this conclusion has been substantiated from the occurrence of injury to the hearing resulting from the shrill blast of a whistle of a certain pitch where the defect has been chiefly for the tones in the same part of the scale as of the whistle which produced the injury. Practically this is undoubtedly of great importance since, even in those occupations where injury to the hearing by continuous over stimulation from noises occurs most frequently, the injury affects primarily the perception for the tones in the upper register of the scale of hearing and leaves, at least for some time, the hearing for the lower tones unaffected to any marked extent. Since it is upon the tones in the lower part of the scale that we rely for conversation, even a more or less extensive defect, if limited to the higher tones, need not be a serious handicap to the individual. One of the most important practical questions to be determined by a further study of occupation deafness is the extent to which these defects may involve the part of the scale used in ordinary conversation. Is it possible for such defects to result in total loss of hearing or even to amount to a serious handicap by making it impossible for the individual to continue with his work or to carry on ordinary conversation.

This question is answered already in the case of locomotive engineers, as has been pointed out above. The deafness among boiler makers obviously does not constitute the occupational handicap that this does among locomotive engineers. It is important, however, to ascertain to what extent boilermakers' deafness may interfere with their carrying on ordinary conversation.

Boilermakers' Deafness.

First; it can be accepted as an established fact that certain occupations associated with loud noises produce permanent injury to the ear. Second; these occupations are chiefly the occupations of engineers and firemen on locomotives, also the occupations in boiler works. Third; that these injuries may constitute a handicap is pretty well established for the engineers on locomotives. It is still an open question whether the degree of deafness resulting from work in factories such as boiler works becomes severe enough to constitute an actual handicap. Fourth; it is my opinion that a further investigation of this subject by a commission would be desirable in order to determine if possible the degree of deafness that may result from injury in such occupations.

I might add further that the impression I had previously held regarding the number of factories in which there is a great noise that could affect the hearing has been very much restricted. Apparently, the volume of the noise is not such an important element; the character of the noise is the necessary factor.

Reports of Drs. Francis Lane and John B. Ellis.

Miner's Nystagmus.

The following is our report of our investigation of miner's nystagmus in the state of Illinois.

Two factors are operating to make this disease less frequent. Firstly: The condition is limited to pick miners, and they are becoming less numerous yearly on account of the increase of machine mining. The following figures, taken from the Illinois Coal Reports for the year ending June 30, 1908, show the percentage of machine mining:

Total quantity of coal mined by hand, 34,062,029 tons; total quantity of coal mined by machine, 15,210,425 tons, or over 30%; total number of men employed about the mine in all capacities, 70,841; total number of men employed in actual mining, 46,194; total number of men employed in machine mining, about 16,000; total number of pick men, 30,194. From the foregoing we see that of the total of 70,841 employed only about 30,194 belong to the class of workmen subject to miner's nystagmus.

Secondly: The disease is confined to those pick men who work with the eyes in an unnatural position, that is, looking upward and to one side. Previous to the passing of the Gross Weight Law some years ago, the men were paid only for coal which would pass over a screen of a certain size. This caused the men to do a lot of overhead pick work in order to obtain the coal in large pieces. The Gross Weight Law forced the owners to pay for the entire quantity mined, and the miners now assume a more natural position.

Of the 30,194 pick men in Illinois, we examined the eyes of about 500, or 1/60 of the entire number, without finding a single case. Two men had complained of subjective symptoms of the disease in the past, but at the time of the examination showed no objective symptoms.

Conclusions. The disease is rare, and, owing to the passage of the Gross Weight Law and the increase of machine mining, it is becoming less frequent in the state of Illinois.

The only cure is cessation of the occupation which caused it. Respectfully submitted,

FRANCIS LANE,
JOHN B. ELLIS.

III. Legal.

Bills for Amendment of Present Law.

The following is a draft of a proposed bill, prepared by Attorney Samuel A. Harper for the Commission, and which is submitted as a definite recommendation, for needed legislation. It is necessarily general in its terms and should ultimately be greatly extended in its scope. Its general provisions were suggested by the investigations the Commission has thus far been able to make. While it does not begin to meet many of the existing evils, if enacted into law it would, in the judgment of the Commission, be a long step in the right direction.

A Bill for an Act to Promote the Public Health by Protecting Certain Employees in this State from the Dangers of Occupational Diseases, and Providing for the Enforcement Thereof.

Section 1. *Be it enacted by the People of the State of Illinois, represented in the General Assembly,* that every employer of labor in this State, engaged in carrying on any work or process which may produce any illness or disease peculiar to the work or process carried on, or which subjects the employees to the danger of illness or disease incident to such work or process, to which employees are not ordinarily exposed in other lines of employment, shall, for the protection of all employees engaged in such work or process, adopt and provide reasonable and approved devices, means or methods for the prevention of such industrial or occupational diseases as are incident to such work or process.

Section 2. Every employer in this State engaged in the carrying on of any process of manufacture or labor in which sugar of lead, white lead, lead chromate, litharge, red lead, arsenate of lead, or Paris green are employed, used or handled, or the manufacture of brass or the smelting of lead or zinc, which processes and employments are hereby declared to be especially dangerous to the health of the employees engaged in any process of manufacture or labor in which poisonous chemicals, minerals or other substances are used or handled by the employees therein in harmful quantities or under harmful conditions, shall provide for and place at the disposal of the employees engaged in any such process or manufacture and shall maintain in good condition and without cost to the employees, proper working clothing to be kept and used exclusively for such employees while at work, and all employees therein shall be required at all times while they are at work to use and wear such clothing; and in all processes of manufacture or labor referred to in this section which are unnecessarily productive of noxious or poisonous dusts, adequate and approved respirators shall be furnished and maintained by the employer in good condition and without cost to the employees, and such employees shall use such respirators at all times while engaged in any work necessarily productive of noxious or poisonous dusts.

Section 3. Every employer engaged in carrying on any process or manufacture referred to in Section 2 of this Act, shall, as often as once every calendar month, cause all employees who come into direct contact with the poisonous agencies or injurious processes referred to in Section 2 of this Act, to be examined by a competent licensed physician for the purpose of ascertaining if there exists in any employee any industrial or occupational disease or illness or any disease or illness due or incident to the character of the work in which the employee is engaged.

Section 4. It is hereby made the duty of any licensed physician who shall make the physical examination of employees under the provisions of Section 3 of this Act, to make an immediate report thereof to the State Board of Health of the State of Illinois upon blanks to be furnished by said Board upon request, and if no such disease or illness is found, the physician shall so report, and if any such disease is found, the report shall state the name, address, sex and age of such employee and the name of such employer, and the nature of the disease or illness with which the employee is afflicted, and the probable extent and duration thereof, and the last place of employment; provided that the failure of any such physician to receive the blanks of the State Board of Health for the making of such report, shall not excuse such physician from making the report as herein provided.

Section 5. The Secretary of the State Board of Health shall, immediately upon receipt of any report from any physician in accordance with the provisions of Section 4 of this Act, transmit a copy thereof to the Illinois Department of Factory Inspection.

Section 6. Every employer engaged in carrying on any process or manufacture referred to in Section 2 of this Act, shall provide, separate and apart from the workshop in which such employees are engaged, a dressing room and lavatory for the use of such employees who are exposed to poisons or injurious dusts, fumes and gases, and such lavatory shall be kept and maintained in a clean and wholesome manner and provided with a sufficient number of basins or spigots with adequate washing facilities, including hot and cold water, clean towels and soap and shower bath, and the dressing rooms shall be furnished with clothes presses or compartments, so that the ordinary street clothes of such employees shall be kept separate and apart from their working clothes.

Section 7. No employee shall take or be allowed to take any food or drink of any kind into any room or apartment in which any process or manufacture referred to in Section 2 of this Act is carried on, or in which poisonous substances or injurious or noxious fumes, dusts or gases are present as the result of such work or process being carried on in such room or apartment, and the employees shall not remain in any such room or apartment during the time allowed for meals, and suitable provision shall be made and maintained by the employer for enabling the employees to take their meals elsewhere in such place of employment, and a sufficient number of sanitary closed receptacles containing wholesome drinking water shall be provided and maintained for the use of the employees within reasonable access and without cost to them.

Section 8. All employers engaged in carrying on any process or manufacture referred to in Section 2 of this Act, shall provide and maintain adequate devices for carrying off all poisonous or injurious fumes

from any furnaces which may be employed in any such process or manufacture, and shall also provide and maintain adequate facilities for carrying off all injurious dust, and the floors in any room or apartment where such work or process is carried on shall, so far as practicable, be kept and maintained in a smooth and hard condition, and no sweeping shall be permitted during working hours except where the floors in such workshop are dampened so as to prevent the raising of dust; and all ore, slag, dross and fume shall be kept in some room or apartment separate from the working rooms occupied by the employees, and where practicable, all mixing and weighing of such ore, slag, dross or fume shall be done in such separate room or apartment, and all such material shall, so far as practicable, be dampened before being handled or transported by employees.

Section 9. When any flues are used in any such process or manufacture referred to in Section 2 of this Act, and such flues are being cleaned out or emptied, the employer shall in every case provide and maintain a sufficient and adequate means or device, such as canvas bags or other practical device, or by dampening the dust, or some other sufficient method for catching and collecting the dust and preventing it from unreasonably fouling or polluting the air in which the employees are obliged to work, and, wherever practicable, the dust occasioned in any process or manufacture referred to in Section 2 of this Act, and any polishing or finishing therein, shall be dampened or wet down, and every reasonable precaution shall be adopted by the employer to prevent the unnecessary creation or raising of dust, and all floors shall be washed or scrubbed at least once every working day; and such parts of the work or process as are especially dangerous to the employees, on account of poisonous fumes, dusts and gases, shall, where practicable, be carried on in separate rooms and under cover of some suitable and sufficient device to remove the danger to the health of such employee, as far as may be reasonably consistent with the manufacturing process, and the fixtures and tools employed in any such process or manufacture, shall be thoroughly washed and cleaned at reasonable intervals.

Section 10. All hoppers or chutes or similar devices used in the course of any process or manufacture referred to in Section 2 of this Act, shall, where practicable, be provided with a hood or covering, and an adequate and sufficient apparatus or other proper device for the purpose of drawing away from the employees noxious, poisonous or injurious dusts, and preventing the employees from coming into unnecessary contact therewith; and all conveyances or receptacles used for the transportation about or the storage in any place where any such process or manufacture referred to in Section 2 of this Act is carried on, shall be properly covered or dampened in such way as to protect the health of the employees, and no refuse of a dangerous character incident to the work or process carried on in any such place, shall be allowed to unnecessarily accumulate on the floors thereof.

Section 11. It shall be the duty of the State Department of Factory Inspection to enforce the provisions of this Act and to prosecute all violations of the same before any magistrate or any court of competent

jurisdiction in this State, and for that purpose such department and its inspectors are empowered to visit and inspect at all reasonable times all places of employment covered by the provisions of this Act. In the enforcement of the provisions hereof the Department of Factory Inspection shall give proper notice in regard to any violation of this Act to any employer of labor violating it, and directing the installment of any approved device, means or method reasonably necessary, in his judgment, to protect the health of the employees therein, and such notice shall be written or printed and shall be signed officially by the Chief State Factory Inspector or the Assistant Chief State Factory Inspector, and said notice may be served by delivering the same to the person upon whom service is to be had, or by leaving at his usual place of abode or business an exact copy thereof, or by sending a copy thereof to such person by registered mail, and upon receipt of such notice calling the attention of the employer to such violation, he shall immediately comply with all the provisions of this Act.

Section 12. If any occupational or industrial disease or illness or any disease or illness peculiar to the work or process carried on, shall be found in any place of employment in this State by the Inspectors of the State Department of Factory Inspection, or called to their attention by the State Board of Health, which disease or illness shall be caused in whole or in part, in the opinion of the inspector, by a disregard by the employer of the provisions of this Act, or a failure on the part of the employer to adopt reasonable appliances, devices, means or methods which are known to be reasonably adequate and sufficient to prevent the contraction or continuation of any such disease or illness, it shall be the duty of the Department of Factory Inspection to immediately notify the employer in such place of employment, in the manner provided in Section 12 of this Act, to install adequate and approved appliances, devices, means or methods to prevent the contracting and continuance of any such disease or illness and to comply with all the provisions of this Act.

Section 13. For the purpose of disseminating a general knowledge of the provisions of this Act and of the dangers to the health of employees in any work or process covered by the provisions of this Act, the employer shall post in a conspicuous place in every room or apartment in which any such work or process is carried on, appropriate notices of the known dangers to the health of any such employees arising from such work or process, and simple instructions as to any known means of avoiding, so far as possible, the injurious consequences thereof, and the Chief State Factory Inspector shall, upon request, have prepared a notice covering the salient features of this Act and furnish a reasonable number of copies thereof to employers in this State, covered by the provisions of this Act, which notice shall be posted by every such employer in a conspicuous place in every room or apartment in such place of employment. The notices required by this section shall be printed on cardboard of suitable character and the type used shall be such as to make them easily legible, and in addition to English they shall be printed in such other language or languages as may be necessary to make them intelligible to the employees.

Section 14. Any person, firm or corporation who shall, personally or through any agent, violate any of the provisions of this Act, or who omits or fails to comply with any of its requirements, or who obstructs or interferes with any examination or investigation being made by the State Department of Factory Inspection in accordance with the provisions of this Act, or any employee who shall violate any of the provisions of this Act shall be deemed guilty of a misdemeanor and on conviction thereof shall be punished for the first offense by a fine of not less than Ten Dollars ($10.00) or more than One Hundred Dollars ($100.00), and upon conviction of the second or subsequent offenses, shall be fined not less than Fifty Dollars ($50.00) or more than Two Hundred Dollars ($200.00), and in each case shall stand committed until such fine and costs are paid, unless otherwise discharged by due process of law.

Section 15. For any injury to the health of any employee proximately caused by any willful violation of this Act or willful failure to comply with any of its provisions, a right of action shall accrue to the party whose health has been so injured, for any direct damages sustained thereby; and in case of the loss of life by reason of such willful violation or willful failure as aforesaid, a right of action shall accrue to the widow of such deceased person, his lineal heirs or adopted children, or to any other person or persons who were, before such loss of life, dependent for support upon such deceased person, for a like recovery of damages for the injury sustained by reason of such loss of life, not to exceed the sum of Ten Thousand Dollars: Provided that every such action for damages in case of death shall be commenced within one year after the death of such employee.

Section 16. The invalidity of any portion of this Act shall not affect the validity of any other portion thereof which can be given effect without such valid part.

Section 17. This Act shall be in force and effect from and after the 1st day of July, A. D. 1911.

The following draft is also submitted as a suggestion for a law to protect workers using compressed air.

A Bill for an Act to Provide For the Health and Safety of Employees Engaged in the Use of Compressed Air in Caissons, Tunnels and Other Work, and Providing for the Enforcement Thereof.

Section 1. *Be it enacted by the People of the State of Illinois, represented in the General Assembly, that* all work in the prosecution of which tunnels, caissons, or other apparatus or means in which compressed air is employed are used shall be conducted subject to the following restrictions and regulations: When the air pressure in any compartment, caisson, tunnel, or place in which men are employed is greater than normal and does not exceed twenty-eight pounds to the square inch, no employee shall be permitted to work or remain therein more than eight hours in any twenty-four hours, and shall only be permitted to work under such air pressure provided he shall during such period return to the open air for an interval of at least thirty consecutive minutes, which interval his employer shall provide for. When the air pressure in any such compartment, caisson, tunnel or place shall exceed twenty-eight pounds to the square inch, and shall not equal thirty-six pounds to the square inch, no employee shall be permitted to work or remain therein more than six hours, such six hours to be divided into two periods of three hours each, with an interval of at least one hour between each such period. When the air pressure in any such compartment, caisson, tunnel or place shall equal thirty-six pounds to the square inch, and shall not equal forty-two pounds to the square inch, no such employee shall be permitted to work or remain therein more than four hours in any twenty-four hours, such four hours to be divided into periods of not more than two hours each, with an interval of at least two hours between each such period; when the air pressure in any such compartment, caisson, tunnel or place shall equal forty-two pounds to the square inch and shall not equal forty-six pounds to the square inch, no employee shall be permitted to work or remain therein more than three hours in any twenty-four hours, such three hours to be divided into periods of not more than ninety minutes each, with an interval of at least three hours between each such period, when the air pressure in any such compartment, caisson, tunnel or place shall equal forty-six pounds to the square inch, and shall not equal fifty pounds to the square inch, no employee shall be permitted to work or remain therein more than two hours in any twenty-four hours, such two hours to be divided into periods of one hour each, with an interval of not less than four hours between each such period; no employee shall be permitted to work in any compartment, caisson, tunnel or place where the pressure shall exceed fifty pounds to the square inch, except in case of emergency. No person employed in work in compressed air shall be permitted by his employer or by the person in charge of said work to pass from the lock in which the work is being done to atmosphere of normal pressure, without passing through an intermediate

lock or stage of decompression, which said decompression shall be at the rate of three pounds every two minutes unless the pressure shall be over sixty-six pounds, in which event the decompression shall be at the rate of one pound per minute. Instruments shall be fitted in all caisson and air locks showing the actual pressure prevailing.

Section 2. Any person or corporation carrying on any work in the prosecution of which tunnels, caissons or other apparatus or means in which compressed air is employed are used shall employ and keep in employment during the prosecution of such work at the place where it is being carried on one or more duly qualified persons to act as medical officer or officers who shall be in attendance at all times while such work is in progress, and whose duty it shall be to administer and strictly enforce the following:

(a) No person shall be permitted to work in compressed air until after he shall have been examined by such medical officer, and reported by such officer to the person in charge thereof as found to be qualified, physically, to engage in such work.

(b) In the event of absence from work by any employee for three or more successive days for any cause, he shall not resume work until he shall have been re-examined by the medical officer, and his physical condition reported, as heretofore provided, to be such as to permit him to work in compressed air.

(c) No person known to be addicted to the excessive use of intoxicants shall be permitted to work in compressed air.

(d) No person not having previously worked in compressed air shall be permitted, during the first twenty-four hours of his employment, to work for longer than one-half of a period as provided in Section 134-a, and after so working shall be re-examined and not permitted to work unless his physical condition be reported by the medical officer, as heretofore provided, to be such as to qualify him for such work.

(e) After a person has been employed continuously in compressed air for a period of three months, he shall be re-examined by the medical officer and he shall not be allowed, permitted or compelled to work until such examination has been made, and he has been reported, as heretofore provided, as physically qualified to engage in compressed air work.

(f) The said medical officer shall at all times keep a complete and full record of examinations made by him, which record shall contain dates on which examinations were made, and a clear and full description of the person examined, his age and physical condition at the time examined, also the statement as to the time such person has been engaged in like employment.

(g) Properly heated, lighted and ventilated dressing rooms shall be provided for all employed in compressed air, which shall contain lockers

and benches and shall be opened and accessible to the men during the intermission between shifts. Such rooms shall be provided with baths, with hot and cold water service and a proper and sanitary toilet.

(h) A medical lock shall be established and maintained in connection with all work in compressed air as herein provided. Such lock shall be kept properly heated, lighted and ventilated and shall contain proper medical and surgical equipment. Such lock shall be in charge of the medical officer.

Section 3. It shall be the duty of the State Department of Factory Inspection to enforce the provisions of this Act and to prosecute all violations of the same before any magistrate or any court of competent jurisdiction in this State, and for that purpose such department and its inspectors are empowered to visit and inspect at all reasonable times, all places of employment covered by the provisions of this act.

Section 4. Any person, firm or corporation who shall personally or through any agent, violate any of the provisions of this Act or who omits or fails to comply with any of its requirements, or who obstructs or interferes with any examination or investigation being made by the State Department of Factory Inspection in accordance with the provisions of this Act, or any employee who shall violate any of the provisions of this Act, shall be deemed guilty of a misdemeanor and on conviction thereof shall be punished for the first offense by a fine of not less than $100 or more than $500, and upon conviction of the second or subsequent offenses, shall be fined not less than $250 or more than $1,000, or imprisonment for one year, or both.

IV. Instructions and Warnings.

Cards of Instructions.

The following are cards of instructions suggested for the use of employees and workmen in dangerous trades. Similar instructions could be made for all the trades in which poisonous substances are handled.

WHITE LEAD FACTORY.

Old Dutch Process.

Employers.

The danger to the workmen in a white lead factory comes from the breathing of dust, from handling food or chewing tobacco with lead-smeared hands, and from getting his hair and clothing and body covered with white lead dust so that he carries it home with him.

The precautions to be observed, consist in prevention of dust as far as possible and in providing for and insisting on personal cleanliness.

The dusty and therefore dangerous processes are: 1st, filling the melting pot with dry cores, which are covered with white lead dust. 2nd, stripping the white beds. 3rd, trucking and dumping corrosions or any form of dry white lead. 4th, emptying drying pans. 5th, filling chasers by hand. 6th, filling barrels or small kegs. 7th, heading up barrels.

The following precautions should be observed by the manager of a white lead factory:

All floors should be smooth and hard and kept free from any accumulation of dust. Dry sweeping should be forbidden. The floors should be kept wet as much as possible.

If hand trucking and dumping are done, the trucks should either be sprinkled to keep down the dust, or covered. The dump must be so arranged that dust is drawn away from the workmen.

All cores and returns should be handled only after a thorough wetting. They should never be left lying exposed to draughts of air.

In emptying the drying pans, long-handled shovels should be used and the powder laid on the trucks, never thrown. All possible precautions against dust should be introduced into this most dangerous part of the factory.

If chasers are filled by hand, great care should be taken not to let the dust fly. All chasers should be covered and the windows kept closed when not in use.

Barrel and keg packing can be done in a cleanly manner without risk to the men. This should be insisted on. No accumulation of white lead should be allowed to form around the barrel packer, and the barrels when rolled out to the shipping room should not be smeared with white. No dusty process should be carried on in the same room with non-dusty processes.

A lavatory with hot and cold water, one spigot for every six men, should be provided, individual towels, or roller towels changed at least twice a day, soap and nail brushes. Shower baths should be provided, sufficient in number to permit all the men engaged in dusty processes to bathe every day. Bathing towels should be provided.

A separate lunch room should be provided and, if possible, a stove for heating the men's lunches.

The men engaged in all of the dusty processes described above should be furnished with some form of respirator.

All employees who come in contact with white lead should be required to

(a) Wear special working clothes and a cap, which clothes and cap are never to be worn outside the factory. These should be kept reasonably clean.

(b) Wash thoroughly face and hands before eating lunch and before quitting work.

(c) Bathe at least once a week. Stack strippers, dry room workers and all exposed continually to dust should bathe each day before quitting work.

(d) Wear respirators while engaged in dusty work. Employees should be forbidden to chew tobacco while at work.

Medical inspection should be held regularly, preferably once a week. The men pronounced unusually susceptible should either be dismissed or assigned to work in which they are not exposed to lead. The same rule should apply to men who return to work after an attack of lead-poisoning.

Time should be allowed the men to wash thoroughly before lunch and at the end of work.

Workmen.

It is dangerous to breathe or swallow white lead dust even in small quantities.

Handling white lead is not necessarily dangerous, because the poison does not pass through the skin. The danger of getting it on the hands is that it may be carried into the mouth.

Lead is a poison that usually enters the body little by little, and gradually accumulates until the system is full of it, when it produces the symptoms of lead-poisoning. This explains why a man may work in white lead for weeks or months without feeling any effects, and then suddenly become violently sick.

The warning symptoms of lead-poisoning are indigestion, foul breath, constipation, paleness, loss of appetite, muscular pains. Alcoholic drinks of all kinds make a man much more susceptible to lead-poisoning.

Working without a proper breakfast in the morning makes a man more susceptible to lead-poisoning. Drinking milk is a good aid against lead-poisoning.

What shall a workman do to protect himself against lead-poisoning?

1. Do not breathe lead dust. Do not do your work or let others do it in such a way as to raise unnecessary dust. Wear a respirator of some kind over your nose and mouth while engaged in any dusty work.

2. Do not eat lead dust. Wash hands, nails, arms and face thoroughly before eating lunch. Do not eat in a room where there is lead dust. Do not chew tobacco while at work, for you will get lead into your mouth from your fingers and mustache and lips.

3. Do not carry lead dust home with you. Leave your working clothes and cap in the factory. Wash face, hair, hands, nails and arms thoroughly before quitting work. If you have been in the dusty parts of the factory, take a bath before going home.

4. Do not drink alcohol.

5. Do not work before eating a sufficient breakfast.

6. Consult a doctor as soon as you feel any symptoms of sickness.

Painting.

Employers.

All painters who use lead salts, dry or ground in oil, are exposed to the danger of lead-poisoning.

The most dangerous process is sand papering or rubbing the dry lead paint. When this is done in a closed room, or still worse in the interior of a railway coach, the workman cannot help inhaling the fine lead dust. Mixing dry white lead with other paints is also dangerous. The making and use of white lead putty is dangerous.

In order to protect the workmen from the risk of lead-poisoning the following rules should be observed.

All sand papering or other dry rubbing of lead paint should be carried on in a separate room and no workman not engaged in that process should be allowed in that room. The rubbers should be obliged to wear overalls, caps and respirators. The floors of the room should be smooth and hard and should be frequently flushed or swept with wet sawdust. No dry sweeping should be allowed. This room should be well ventilated.

Dry white lead should be handled only in one special room, where all mixing of paints and putty should be carried on. The white lead should be kept in a closed receptacle, and in handling it care should be taken not

to raise dust. The floor of this room should be frequently flushed or swept with wet sawdust.

Painters using lead paints should be warned of the dangerous nature of their trade. They should be furnished overalls and caps. Wash rooms, with hot water, soap, towels and nail brushes should be provided, and the men obliged to wash thoroughly before lunch and before quitting.

A lunch room should be provided and no one should be allowed to eat or keep lunch in one of the workrooms.

The use of tobacco should be forbidden during working hours.

In sand papering old paint the same precautions should be observed as in sand papering new paint.

In burning off old paint, care should be taken to sweep up the fragments of paint before they dry and become dusty.

Workmen.

Any man who works with lead paints, lead putty, or dry white, yellow or red lead runs the risk of lead-poisoning unless he observes certain precautions.

Handling white lead is not necessarily dangerous, because the poison does not pass through the skin. The danger of getting it on the hands is that it may be carried into the mouth.

Lead is a poison that usually enters the body little by little and gradually accumulates until the system is full of it, when it produces the symptoms of lead-poisoning. This explains why a man may work with lead paint for months or years without feeling any effects, and then suddenly become violently sick.

The warning symptoms of lead-poisoning are indigestion, foul breath, constipation, paleness, loss of appetite, muscular pains. Alcoholic drinks of all kinds make a man much more susceptible to lead-poisoning.

What shall a painter do to protect himself against lead-poisoning?

Do not breathe lead dust. If you are sand papering or rubbing dry lead paint or putty, which is the most dangerous part of a painter's work, wear overalls, a cap and some form of respirator over your nose and mouth.

Do not eat lead dust. Wash hands, nails, arms and face thoroughly before eating lunch. Do not eat in a room where there is lead dust. Do not chew tobacco while at work, for you will get lead into your mouth from your fingers, mustache and lips.

Do not carry lead dust home with you. Leave your working clothes and cap in the factory. Wash face, hair, hands, nails and arms thoroughly before quitting work.

Remember that the paint or dust you get on your hands, face and arms will not poison you by going through the skin but by being carried into your mouth.

Do not drink alcohol.

Do not work before eating a sufficient breakfast.

Consult a doctor as soon as you feel any symptoms of sickness.

Commercial or Mechanical Artists.

The majority of the white water-colors used by artists contain white lead and are poisonous.

Handling white lead is not necessarily dangerous, because the poison does not pass through the skin. The danger of getting it on the hands is that it may be carried into the mouth.

Lead is a poison that usually enters the body little by little, and gradually accumulates until the system is full of it, when it produces the symptoms of lead-poisoning. This explains why a man may work with white lead for weeks or months without feeling any effects, and then suddenly become violently sick.

The warning symptoms of lead-poisoning are indigestion, foul breath, constipation, paleness, loss of appetite, muscular pains. Alcoholic drinks of all kinds make a man much more susceptible to lead-poisoning.

To guard against lead-poisoning it is essential that an artist keep from swallowing white lead paint or breathing in white lead dust. It is very dangerous to put the brush into the mouth and most of the lead poisoning among artists comes from this habit. The use of the air brush is less dangerous, but whenever this is used in such a way as to fill the air with spray, a handkerchief should be tied over the mouth and nose of the person so using it.

It is essential that the hands and face should be carefully washed before meals, especial attention being paid to the nails.

Storage Batteries.

Employers.

The danger to men engaged in making storage batteries comes from the handling of the oxides of lead or from breathing the dust of the exides or the fumes from the melting pot. Red lead and litharge are often considered harmless, but this is a great mistake. Although not as dangerous as white lead they are decidedly poisonous and many severe cases of lead-poisoning have been reported from storage battery works.

The mixing and grinding of the oxides, the pasting, and the casting of grids should all be done in separate rooms. All of these rooms should have floors of some smooth, hard material which should be kept as clean as possible. No accumulation of dust should be allowed anywhere. There should be no dry sweeping. All floors should be cleaned once a day. The kettle should be properly protected by a hood with an exhaust. Dross should be thrown into a proper receptacle, not on the floor.

Nobody should be allowed in the mixing room except the men engaged in mixing and grinding. This room should be kept as clean as possible. It is well to have the floor sprinkled with water frequently. It is advisable to have the paste for the plates made in this room and distributed ready-made to the pasters. Where this is not done, and the pasters are required to make their own paste, special precautions should be used. The work of mixing powder and fluids should be carried on in such a way as to effectually protect the men against dust. In either case the paster's table should be of hard, smooth material, cleaned thoroughly once a day. The room should be abundantly ventilated. Care should be taken not to let paste fall on the floor.

Removal of superfluous paste should be done before the plate is dry, not after, as this causes dust.

The room in which the lead burning is done should be abundantly ventilated.

If old battery plates are recharged or remelted, they should be sprinkled with water before being handled and should be stored under cover, as they give rise to a dangerous amount of dust.

The men handling old battery plates, pasting, drying and mixing, should wear overalls, caps and boots, which should be left in the factory. If the work in any part is productive of dust, the men engaged in that work should wear some form of respirator.

Adequate washing facilities should be provided, hot and cold water, one spigot to every six men, towels, nail-brushes and soap. The pasters and mixers should have separate towels. The men should be given time to wash thoroughly before lunch and before quitting work and should be obliged to do so. A lunch room should be provided and the workmen forbidden to keep or eat food in any other room.

Medical inspection should be made of all the men engaged in mixing, pasting, drying and handling old plates, at least once a month, and any man found especially susceptible to lead-poisoning should be discharged or put to safer work. The same rule should apply to a man returning to work after an attack of lead-poisoning.

No boy under eighteen years of age, and no woman, should be employed in casting, mixing, pasting, assembling or handling old plates.

Storage Batteries.

Workmen.

The grid of a storage battery plate is made of lead and the paste is made of lead salts.

Handling lead is not necessarily dangerous, because the poison does not pass through the skin. The danger of getting it on the hands is that it may be carried into the mouth.

Lead is a poison that usually enters the body little by little, and gradually accumulates until the system is full of it, when it produces the symptoms of lead-poisoning. This explains why a man may work in lead for weeks or months without feeling any effects, and then suddenly become violently sick.

The warning symptoms of lead-poisoning are indigestion, foul breath, constipation, paleness, loss of appetite, muscular pains. Alcoholic drinks of all kinds make a man much more susceptible to lead-poisoning.

Working without a proper breakfast in the morning makes a man more susceptible to lead-poisoning. Drinking milk is a good aid against lead-poisoning.

What shall a maker of storage battery plates do to guard against lead-poisoning?

If at the melting pot, use your ladle with care so as not to stir up fumes. These fumes can be seen and are always dangerous. Do not throw dross skimmings on the floor. Do not let lead dust accumulate anywhere in the room. If you must remelt old plates, always sprinkle them well with water before handling them, for the dust from them is very bad.

If in the grinding and mixing room, wear some form of respirator over nose and mouth. Be careful not to raise any unnecessary dust.

If at the pasting table, be very careful not to raise dust while making paste. Keep your hands as clean as possible. If dust is unavoidable, wear a respirator over nose and mouth.

Do not shake or scrape the plates after they are dry. Excess of paste should be removed while the plates are moist. Handle the dry plates carefully, for the dust is dangerous.

Lead does not poison a man through the skin, but only by getting into the nose and mouth.

Always wash carefully before eating. Do not eat in a room where there is lead dust. Do not chew tobacco while at work, for you will get lead into your mouth from your fingers, mustache and lips.

Do not carry lead dust home with you. Leave your working clothes and cap in the factory. Wash face, hair, hands, nails and arms thoroughly before quitting work. If you have been in the dusty parts of the factory, take a bath before going home.

Do not drink alcohol.

Do not work before eating a sufficient breakfast.

Consult a doctor as soon as you feel any symptoms of sickness.

Working without a proper breakfast in the morning makes a man more susceptible to lead-poisoning. Drinking milk is a good aid against lead-poisoning.

V. Appendix

Provisions of Protective Laws in States of the Union and in European Legislation.[1]

(Not proposed for action of Legislature, but for information.)

PART I.

General Regulations Relating to Health and Safety.[2]

(*I*) HEALTH.

Section 1. (1) The following provisions shall apply to every factory,[3] [4] mercantile[4] establishment[4] and mill[4] or workshop[4] as hereinafter defined,[5] except as hereinafter excepted:[5]

(a) It must be kept clean.[6]

(b) It must be kept free, so far as possible,[7] from effluvia arising from any sewer, drain, water closet, earth closet, privy, urinal, or other nuisance.[6]

(c) It must be ventilated so as to render harmless, as far as practicable, all the gases, fumes, vapors, dust, or other impurities generated in the course of any manufacturing process or handicraft carried on therein, that may be injurious to health.[6]

(d) It must not be so overcrowded while work is carried[6] on therein as to be dangerous or injurious to the health of the persons employed therein.[6] [8]

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[1] The method and the form pursued in offering these "suggestions" follow the British "Factory and Workshop Act, 1901." The language of the Act is often embodied *verbatim;* in some portions only partially followed, and in other parts mingled with that from other sources or adapted to the requirements of the case by Mr. Albert J. Norton, of the Chicago Bar, who drafted the suggestions and annotated the text. The citations of the Act are made from "Butterworth's Twentieth Century Statutes [Annotated], Being the General Acts Passed in the Years 1900-1909, Excluding Acts in Force Only in Scotland," etc., "Issued Under the General Editorship of H. H. King, Esq., B. A., LL. B., of the Inner Temple, Barister-at-Law," Vol. II, London, Butterworth & Co., 1910.

The title of the Act is as follows: "Factory and Workshop Act, 1901, 1 Edw. 7, c 22.

"An Act to Consolidate with Amendments the Factory and Workshop Acts." [17th August, 1901.]

[2] *Ibid,* 109, Sec. 1, Subsection (1) of Part I. The Commission's authority is not sufficiently broad to include the subject "Safety" covered by the English Act, and no further reference is made to it in the draft.

[3] *Ibid,* 109, Sec. 1, Subsection (1) of Part I.

[4] Hurd's *Rev. Stats. Ill.,* 1909, C. 48, p. 1102, *Act to Provide for the Health, Safety and Comfort of Employes,* etc., slightly changed.

[5] Norton—slightly changing wording of Eng. Act.

[6] 2 Butt., *Twent. Cent. Statts.,* 109, 110, *Fact and Wkshp. Act,* 1901, Part I, Sec. 1, Subsec. (1) (a) (b) *verbatim.*

[7] The words "so far as possible" added at suggestion of Chief State Factory Inspector Edgar T. Davies.

[8] Idea of this paragraph good but impracticable as worded because the manufacturing processes carried on in many of the establishments of the classes named are "necessarily overcrowded to a point of danger." *Ibid.*

(2) All inside rooms of a factory, mercantile establishment, mill, or workshop, and all ceilings or tops of such rooms, whether walls, ceilings or tops are plastered or not, and all passages and staircases of such factory, mercantile establishment, mill, or workshop, shall be limewashed at least once in every twelve months, or as much oftener as in the opinion of the state administrative authority, created according to the provisions of this act, and hereinafter designated for convenience, as ....., will be conducive to the health and cleanliness, or either, of the persons working therein; or shall be painted or varnished or otherwise sufficiently cleansed to secure the results sought in this section; such limewashing, painting, or varnishing or other cleansing process shall, however, be subject to special exceptions made in pursuance of this section.[9], [10]

(3) A factory, mercantile establishment, mill, or workshop in which there is a violation of the provisions of this section shall be deemed not to be kept in conformity with this act.[11]

(4) If, in the opinion of any deputy medical factory inspector, appointed as hereinafter provided, and hereinafter for convenience called "medical inspector," the limewashing, cleansing, or purifying of any factory, mercantile establishment, mill, or workshop, or any part thereof, required in this section, it is necessary for the health of the persons employed therein, he or she shall give notice to the person or persons owning, operating, or managing any such factory, mercantile establishment, mill, or workshop, or any part thereof, to be limewashed, or otherwise cleansed, to limewash or otherwise cleanse or purify the same, as the case may be.[12]

(5) If the person or persons so notified fails, or fail, to comply with such notice within the time specified, to be not less than.....days from the date of service thereof, he or they shall be liable to a fine not exceeding $..... for every day that he continues, or they continue, to make default; and if, on reporting the results of his or her investigation to the state administrative authority, the latter so directs, such medical inspector or any other proper officer under the law, may cause such factory, mercantile establishment, mill, or workshop to be limewashed

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[9] The language of this sub-section is mainly that of the English Act, 2 Butt., *Twent. Cent. Stats.*, 110, Pt. I, Sub-sec. (3). The period named in the English Act is 14 months. If the walls, etc., are painted or varnished at least once within 7 years, they need not be limewashed, but must be washed with soap at least once within 14 months.

[10] This sub-section seems to be a copy of the English provisions, and was seriously objected to by the manufacturers of the state, when a clause to this effect was included in "my original bill No. 500 and was eliminated by the Industrial Commission." C. S. F. Insp. Edgar T. Davies.

[11] 2 Butt., *Twent. Cent. Stats., F. W. Act,* 1901, Pt. I, (5).

[12] 2 Butt., *Twent. Cent. Stats.,* pp. 110, 111, *F. and W. Act,* 1901, Pt. I, Sec. 2, (3). The idea of the English Act is here used, but the language is considerably changed and adapted to the ideas and form proposed in these suggestions. The English Act provides that the District Council, on certificate of a medical officer of health, shall give the notice provided for in the text. The District Council in the English Act is an administrative body of the "district," a subordinate division of a county, having large powers in sanitary matters.—Albert J. Norton.

or otherwise cleansed, or purified, and may recover before any magistrate or court of competent jurisdiction all expenses and the costs of the proceedings instituted for that purpose from the person or persons in default.[13]

Section 2. (1) A factory, mercantile establishment, mill, or workshop, for the purposes of this act and of the laws relating to public health, shall be deemed to be so overcrowded as to be dangerous or injurious to the health of the persons employed therein, if the number of cubic feet of space in any room therein bears to the number of persons employed therein at one time in the room a proportion less than 500, or, during any period of overtime, 500 cubic feet of space to each person;[14] *Provided*, that in case lights are used that do not consume oxygen 250 cubic feet of space shall be deemed proper proportion.[15]

(2) A notice shall be affixed in every factory, mercantile establishment, mill, or workshop, which shall specify the number of persons that may be employed in each room thereof by virtue of this section.[16]

Section 3. (1) In case it appears to any inspector, not a medical inspector, that any act, neglect, or default, in relation to any drain, watercloset, earthcloset, privy, urinal, nuisance, or any other matter in a factory, mercantile establishment, mill, or workshop, is punishable or remediable under a law or laws relating to the public health, but not under this act, that inspector shall refer the matter to the medical inspector within whose district the premises complained of are situated, and if that medical inspector is of the opinion that there is a violation of such law or laws, that inspector or that medical inspector shall give notice in writing of the act, neglect, or default, to the local board of health, or other proper authority in the district in which the premises complained of are situated, which local board of health or other proper authority shall make such inquiry into the subject matter of the notice, and shall take such action thereon as seems to that local board of health or other competent authority to be proper to enforce the law, and to inform that inspector or that medical inspector, as the case may be, of the proceedings taken in consequence of the notice.[17]

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[13] 2 Butt., *Twent. Cent. Stats.*, p. 111, *F. and W. Act*, 1901, Pt. I, Sec. 2, (4). This is substantially the language of the English Act. C. S. F. Inspector Davies suggests that it should specify the person or persons in default and the "other proper officers," etc., whether the police department, etc., of a city, or the health or food department of the state, etc.

[14] The language of the English Act, 2 Butt., *Twent. Cent. Stats.*, p. 111, Pt. I, Sec. 3, (1) of *F. and W. Act*, 1901, except that in that Act the figures are 250 and 500, respectively. From his experience, C. S. F. Inspect. Davies believes that this provision is impracticable, because of varying cubic measurements and a too heavy percentage of carbon dioxide (CO^2) in some cases.

[15] This is the language used in the Illinois Act of 1909, found as the last clause of the first sentence of Sec. 99, C. 48 Hurd, *Rev. Stats. Ill.*, on p. 1104.

[16] The language of the English Act *verbatim*, *Sub sec.* (4), p. 112, 2 Butt., etc.

[17] The main idea taken from the English Act, 2 Butt., *Twent. Cent. Stats.*, p. 112, *Sec.* 5 (1), but much modified, to conform to the theory of these suggestions.—Albert J. Norton. General criticism of C. S. F. I. Davies that there is likely to be a conflict of authority and considerable confusion among officers that may, under the present laws, enforce such provisions as are contained in this sub-section.

(2) In case notice of an act, neglect, or default is given by an inspector or medical inspector under this section to a local board of health, or other proper authority, and proceedings are not taken within one month to punish or remedy the act, neglect, or default, the inspector may take like proceedings to punish or remedy the same, that the local board of health or other proper authority might have taken; and shall be entitled to recover from that local board of health or other proper authority all such expenses and costs in and about the proceedings that the inspector incurs and that are not recovered from any other person or persons and have not been incurred in any unsuccessful proceedings.[18]

Section 4. (1) In every factory, mercantile establishment, mill, or workshop, in which one person or more persons is or are employed, adequate measures must be taken to secure and to maintain a reasonable temperature in each room in which any person is employed, but the measures so taken must not unnecessarily or materially interfere with the purity of the air of any room in which any person is thus employed.[19]

(2) A factory, mercantile establishment, mill, or workshop in which there is any violation of this section, or of any order under this section, shall be deemed not to be kept in conformity with this act.

Section 5. (1) In every room or apartment of any factory, mercantile establishment, mill, or workshop, where one or more persons are employed, at least 500 cubic feet of air space shall be provided for each person employed therein, and fresh air, to the amount specified in this act, shall be supplied in such a manner as not to create injurious drafts, nor cause the temperature of any such room or apartment to fall materially below the average temperature maintained: *Provided,* where lights are used which do not consume oxygen, 250 cubic feet of air space shall be deemed sufficient. All rooms or apartments of any factory, mercantile establishment, mill, or workshop, having at least 2,000 cubic feet of air space for each person employed in each room or apartment, and having outside windows and doors whose area is at least one-eighth of the total floor area, shall not be required to have artificial means of ventilation; but all such rooms or apartments shall be properly aired before beginning work for the day and during meal hours. All such rooms, or apartments, having less than 2,000 cubic feet of air space, but more than 500 cubic feet of air space, for each person employed therein, and which have outside windows and doors whose area is at least one-eighth of the floor area, shall be provided with artificial means of ventilation which shall be in operation when the outside temperature requires the windows to be closed, and which shall supply during each working hour at least 1,500 cubic feet of fresh air for each person employed therein. All such rooms or apartments having less than 500 cubic feet of air space for each person employed therein, all rooms or apartments having no outside doors or windows, and all rooms or apartments having less than 3,000 cubic feet of air space for each person

[18] This is the latter part of Sub-sec. (1) of Sec. 5 of the English Act modified in conformity with the theory of these suggestions.

[19] Language of English Act, 2 Butt., *Twent. Cent. Stats.*, 113, *F. and W. Act*, 1901, Pt. I, Sec. 6, (1). Theory of this provision good. Should add a standard for carbon dioxide, which requires a graded standard.—C. S. F. I. Davies.

employed therein, and in which the outside window and door area is less than one-eighth of the floor area, shall be provided with artificial means of ventilation, which shall supply during each working hour throughout a year, at least 1,600 cubic feet of fresh air for each person employed therein: *Provided*, that the provisions of the preceding portions of this sub-section shall not apply to storage rooms or vaults; and, *provided further,* that the preceding portions of this sub-section shall not apply to those rooms or apartments in which manufacturing processes are carried on which from their peculiar nature would be materially interfered with by the provisions of this sub-section. No part of the fresh air supply required by this sub-section shall be taken from any cellar or basement.

The following terms of this sub-section shall be interpreted to mean: The air space available for each person is the total interior volume of a room expressed in cubic feet, without any deductions for machinery contained therein, divided by the average number of persons employed therein.

Outside windows and doors are those connecting directly with the outside air; the window and door area is the total area of the windows and doors of all outside openings; and the floor area is the total floor area of each room.[20]

(2) A factory, mercantile establishment, mill, or workshop in which there is a violation of the provisions of this section shall be deemed not to be kept in conformity with this act, and shall be deemed to be a nuisance and liable to be dealt with as under the laws relating to public health.

Section 6. (1) In every factory, mercantile establishment, mill, or workshop, in which any process is carried on that makes the floors wet the floors shall be constructed and maintained with due regard to the health of the employees, and gratings or dry standing rooms shall be provided, if practicable, at points where employees are regularly stationed, and adequate means for draining and preventing seepage or leakage, if any, to the floors below, shall be provided.[21]

(2) In every factory, mercantile establishment, mill or workshop, all decomposed, fetid or putrescent matter, and all refuse, waste and sweepings thereof, shall be removed and disposed of at least once each day, and in such manner as not to cause a nuisance; and all cleaning shall be done as far as possible, outside of working hours; but if done during working hours, it shall be done in such a manner as to avoid the unnecessary raising of dust or of noxious odors.[22]

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[20] This section is Sec. 99, C. 48, Hurd's *Rev. Stats. Ill.*, 1909, p. 1104, Act of 1909, to Provide for Health, etc., of Employes. C. S. F. I Davies suggests that the state administrative authority be empowered to enforce various sections of different existing statutes in relation to the subject-matter in hand.

[21] Last sentence of Act, 1909, To Provide for Health, etc., of Employes, Hurd's *Rev. Stats. Ill.*, 1909, C. 48, Sec. 101, on p. 1105.

[22] First sentence of Sec. 101, referred to in the preceding note.

(3) Every factory, mercantile establishment, mill or workshop, in which there is a violation of the provisions of this section, shall be deemed not to be kept in conformity with Act and a nuisance liable to be dealt with under the laws relating to public health.

Section 7. Every factory, mercantile establishment, mill or workshop, shall be provided with a sufficient number of waterclosets, earthclosets, or privies, within reasonable access of the persons employed therein, and such waterclosets, earthclosets or privies shall be supplied in the proportion of at least one (1) to every thirty (30) male persons, and one (1) to every twenty-five (25) female persons; and whenever both male and female persons are employed, said waterclosets and privies shall be provided separate and apart for the use of each sex and plainly marked by which sex they are to be used, and no person or persons shall be allowed to use closets or privies assigned to the opposite sex, but such waterclosets or privies shall be constructed in an approved manner and properly enclosed, and at all times kept in clean and sanitary condition. The closets or privies, where practicable, shall be located so that they shall have direct ventilation with the outside air; where it is impracticable to locate the closets or privies so as to have direct ventilation with the outside air, they shall be placed in an enclosure; and every such closet or privy shall be properly and effectively disinfected and separately ventilated, and shall be properly lighted by artificial light, except when the influx of natural light makes artificial light unnecessary.[23]

Provided, that nothing in this section shall be construed to prevent any city, town or village, by appropriate ordinance or regulation, from prohibiting the construction, use or maintenance in such city, town or village, of any kind of earthclosets, or privies, which may be considered a nuisance or detrimental to the public health.[23]

Section 8. (1) In all factories, mercantile establishments, mills, or workshops, adequate washing facilities shall be provided for the employes where necessary, and in such case in all factories, mills and workshops not less than one spigot, basin or receptacle shall be provided for each thirty (30) employes; and in mercantile establishments, not less than one spigot, basin or receptacle shall be provided for each fifty (50) employes. Where the labor performed by the employes is of such a character as to make customary or necessary a change of clothing by the employes, there shall be provided sanitary and suitable dressing room or rooms, and both such dressing rooms and washing facilities shall be separately maintained for each sex.[24]

[23] Hurd's *Rev. Stats. Ill.*, 1909, p. 1105, Sec. 108, Health and Safety Act of 1909.

[24] *Ibid.*, p. 1106, Sec. 109. C. S. F. I. Davies suggests that the present law be changed to the effect that dressing rooms shall be maintained for employes and their clothing changed before appearing on the street, where the character of the work is such that it is advisable for health and comfort of the employes not to wear the same clothes on the street and in their homes that they wear at work. He further suggests compulsory maintenance by employers of bath rooms with tubs and shower baths, say, for example, for puddlers, molders, in rolling mills, mines and in some manufacturing places.

Provided, That nothing in this Act shall be construed as abrogating or repealing any provision of section 5 of an Act entitled "An Act to Provide for the Licensing of Plumbers and to Supervise and Inspect Plumbing," approved June 10, 1897, and enforced July 1, 1897, or the provisions of any legal ordinance or regulation of any city, town or village requiring approved and sufficient methods of sanitation, light, heat, drainage or ventilation of an equal or superior standard to that required in this Act.[25]

(2) It shall be the duty of every person, firm or corporation to which the provisions of this Act may apply, to carry out the same, and make all changes and additions necessary therefor, and in every way to comply with the provisions of this Act, and it shall be the duty of the owner of the building in which is located any such factory, mercantile establishment, mill or workshop, to permit any alteration or addition to such building as may be necessary to comply with the provisions of this Act.[26]

(3) Whenever, by the provisions of this Act, it is made the duty of any person, firm or corporation within this State, to make or install any alterations, additions or changes, the same shall be made and installed in conformity with the provisions of this Act, and completed within a reasonable time after time of notification by the State administrative authority.[26]

(4) The provisions of this Act relating to sanitation and ventilation shall not be held to apply to such rooms or apartments of any factory, mercantile establishment, mill or workshop, which are being operated under the supervision of the federal government by virtue of an Act of Congress entitled "An Act Making Appropriations for the Department of Agriculture for the Fiscal Year Ending June 30, 1906," or any amendment thereof; nor shall any other of the provisions of this Act so apply respecting matters and conditions over which the federal government now exercises jurisdiction.[27]

Section 9. (1) The State administrative authority shall determine what shall be deemed a compliance with the provisions of sections 8 and 9 of this Act as to what is a sufficient number of watercloset, earth-closets or privies, their proper proportion and sanitary condition, and as to what are adequate washing facilities.[28]

(2) Every factory, mercantile establishment, mill or workshop in which there is a violation of any of the provisions of sections 7 and 8 of this Act shall be deemed not to be in conformity with the provisions of this Act.

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[25] This is a part of Sec. 109 referred to in the preceding note.

[26] This is Sec. 110 of Act, 1909, Hurd's *Rev. Stats. Ill.*, 1909, p. 1106, C. 48, as to Health, etc., of Employes. C. S. F. I. Davies thinks that present law can be improved by providing that the lessee or the owner should make the changes and that the lessee might recover from the lessor or owner such proportion of money expended as would be his proper share for such changes as would be permanent improvements.

[27] This is Sec. 116 of the 1909 Act, Hurd's *Rev. Stats. Ill.*, p. 1108.

[28] This is the language of the annotator.

PART II.

EMPLOYMENT.

Women, Young Persons, and Children.

Prohibition Against Employing Children in Certain Occupations.

Section 10.[29] No child, as defined in this act, shall be employed or permitted to work at any gainful occupation, to whomever gainful, as follows:

(1) In any theatre, concert hall, or place of amusement where intoxicating liquors are sold, or given away; or

(2) In any capacity whatever in the manufacture of goods for immoral purposes, or in any occupation in which the morals of a child may thereby become depraved or in which life or limb is endangered or health impaired; or

(3) In preparing any composition in which dangerous or poisonous acids or other poisonous substances are used; nor in the manufacture of paints, colors or white lead;[30] or

(4) In any factory, mercantile establishment, mill, workshop, store, hotel, office, laundry, manufacturing establishment, bowling alley, passenger or freight elevator, telegraph office, or other similar place, or as a messenger or driver of or for any of the before named establishments or working places; or in any other occupations that are dangerous to the life or limb of such child.

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[29] The English Act has been followed in this section as to form. See 2 Butt., *Twent. Cent. Stats.*, p. 123, *F. and W. Act*, 1901, Pt. II, (i) Sec. 23.

The sub-sections of this section are taken from the Act to regulate the Employment of Children, etc., of 1897, Hurd's *Rev. Stats. Ill.*, 1909, p. 1085, C. 48, Sec. 33; and from the Act with a similar title, of 1903, *Ibid.*, p. 1079, Sec. 20; and p. 1082, Sec. 20j. Only portions of these sections have been used and they have been rewritten to conform to the general theory of the suggestions.—Albert J. Norton.

The comments of Chief State Factory Inspector Edgar T. Davies on the provisions of this section are very interesting and valuable. In his opinion, a child of a certain age may properly appear in some concert halls or places of amusement, but should not appear in a theatre; in some cases, however, a young child might appear in a theatre; he would not permit a girl under the age of 18 years to be employed or to take part in a chorus, a theatrical production or an amusement enterprise, in the character of a "broiler."

Mr. Davies thinks that the proposed section, as well as the present law, would prohibit choir boys, church entertainments, etc., but would permit very young children to appear in theatres, etc., without pay, and not violate the law. It would seem from what Mr. Davies says that there is an old law in existence that can be applied without being in conflict with the present child labor law. This law, no doubt, ought to be repealed.

[30] Mr. Davies would include in this sub-section all the prohibitions that appear in Sec. 20j, Hurd, p. 1082, and would add other prohibitions.

(*ii*) *Prohibition Against Employing Young Persons Under the Age of Sixteen Years in Certain Occupations, Etc.*

Section 11. (1)[31] No young person under the age of sixteen years, as defined in this Act, shall be employed or permitted to work at any gainful occupation to whomever gainful named in sub-sections one, two and three of the preceding section; nor in any other occupations that are dangerous to the life or limb of such young person.

(2)[32] No young person under sixteen years of age shall be employed or permitted to work in any factory, mercantile establishment, mill, workshop, store, hotel, office, laundry, manufacturing establishment, theatre, concert hall, or place of amusement, bowling alley, passenger or freight elevator, telegraph office or similar place, or as a messenger or driver of or for any of the above named establishments or working places, unless there are produced and placed on file the age and school certificate now required by law and the certificate[33] of fitness[33] for employment[33] required under this Act.

(3) No female young person under the age of sixteen years shall be employed in any occupation that compels her to remain standing constantly.

(*iii*) *Hours and Holidays.*

Section 12. No woman as defined in this act, and no young person as defined in this act, shall be employed in any factory, mercantile establishment, mill or workshop, and no child, as defined in this act, shall be employed in any occupation, except during the period of employment hereinafter mentioned. The provisions of Part II of this act in an especial manner have as their aim the public health and welfare, together with the health, safety and comfort of the classes of persons that are the objects of its provisions.

Section 13.[34] (1) No woman and no young person shall be employed in any mechanical establishment or factory or in any laundry more than ten hours of the twenty-four hours in any one day; and

(2) No young person shall be employed in any mercantile establishment, mill or workshop more than ten hours in any one day; and

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[31] Inspector Davies suggests that this sub-section as drawn might, perhaps, permit children of any age to appear upon the stage of any theatre if no liquor is sold in the establishment.

[32] The language of this sub-section is an adaptation of that of a portion of the child labor law of 1903, Hurd's *Rev. Stats. Ill.*, p. 1079, Secs. 20a, 20b, 20c, with the addition of two occupations not named in the statute.

[33] The "certificate of fitness for employment" here introduced is taken from the English Act. As to what it is see 2 Butt., *Twent. Cent. Stats., Fact. and Work. Act*, pp. 142, 143, 1901, Pt. II, sub head (iii) "Fitness for Employment," sub-sections (1)-(8).

[34] The general form, and the style of language used in this section is similar to that of the English Act. The substance of the provisions embodies the ideas of the drafter of these suggestions.

(3) No young person under the age of sixteen years shall be permitted to work at any gainful occupation more than eight hours in any one day nor more than forty-eight hours in any one week.[35]

(4) No child shall be permitted to work more than eight hours in any one day nor more than forty-eight hours in any one week.[35]

Section 14.[36] With respect to the employment of women and young persons more than sixteen years old in factories, mercantile establishments, mills and workshops, the following regulations shall be observed:

(1) The period of employment, except on Saturday, may begin at six o'clock in the forenoon and end at four o'clock in the afternoon, or begin at seven o'clock in the forenoon and end at five o'clock in the afternoon, or begin at eight o'clock in the forenoon and end at six o'clock in the afternoon.

In drafting any law on the subject-matter of this section, the decision of the Supreme Court of Illinois in the case of *Ritchie* v. *The People*, 155 Ill., 98, and of *Ritchie & Co.* v. *Wayman*, 244 Ill., 509, must be kept carefully in mind. The decision in the former case was rendered in 1895 and in the latter case in April, 1910. The court cites numerous authorities in each of these cases.

Inspector Davies doubts whether public opinion is sufficiently advanced to indorse a prohibition against a young man's working more than 10 hours a day, that is, a "young man eighteen, nineteen or twenty years of age." It is to be noted that according to the definition of a "young person" in Part VI, the maximum age is 18 years.—Albert J. Norton.

Inspector Davies points out the fact, as he asserts, that employers and their women employes protest against a ten hour restriction, the strongest protest coming from the women employes. Some consider it reasonable, he says, "that the Ten Hour Law for women be so worded as to permit of exceptions for a few days in the week, or a few weeks, in some instances a month, when women employes should be permitted to work twelve (12) hours a day; for instance, in laundries, following a holiday, or when a holiday follows a Sunday, that the two days next ensuing the women be allowed to work twelve hours a day; in the canning factories, where the seeds are contracted for before the seeds are planted, they having to take the entire crop over when the crop has reached the ripening stage, and in canning corn, tomatoes and goods of every description under great pressure for time because the goods are perishable and help is hard to obtain and a good portion in the rush season are the wives and daughters of employes in the earlier season, women should be allowed to work longer hours." Mr. Davies also refers to the candy trade as one of "many lines of endeavor" not included in his summary above quoted.

The English Factory and Workshop Act of 1901 has many provisions in Part II, making exceptions as to the period of employment, holidays, half-holidays and overtime, along the lines suggested by Mr. Davies. The Secretary of State, under that Act, can make exceptions as to these matters by means of "Special Orders." —Albert J. Norton.

[35] Taken from the child labor law of 1903, Hurd's *Rev. Stats., Ill.*, p. 1079, C. 48, Sec. 20, and p. 1082, Sec. 20i.

[36] The ideas and language of this section are mainly taken from the English Act, 2 Butt., p. 123, 124, Pt. II, subhead (i), Secs. 23, 24. The ordinary period of employment under the Fact. and Work. Act of 1901 is 12 hours a day, and ample provision as to the length of time allowed for meals are inserted in that Act. The times when the period of employment may begin and end and the period allowed for meals in this draft are somewhat different in some cases from those in the English Act and are made by way of suggestion merely.

(2) The period of employment on Saturday may begin at six o'clock in the forenoon and end at twelve o'clock noon, or begin at seven o'clock in the forenoon and end at one o'clock in the afternoon, or begin at eight o'clock in the forenoon and end at two o'clock in the afternoon.

(3) No woman or young person shall be employed continuously, that is to say, without an interval of at least half an hour's duration, for more than four and one-half hours without an interval of at least half an hour for a meal.

Section 15.[37] (1) No young person under the age of sixteen years and no child shall be employed continuously, that is to say, without an interval of at least half an hour's duration, for more than four hours without an interval of at least half an hour for a meal; and

Section 16.[38] There shall be allowed women, young persons and young persons under the age of sixteen years, for meals in every factory, mercantile establishment, mill or workshop during such period of employment, as follows:

(a) On every day except Saturday, not less than one hour and a half in factories, mechanical establishments and laundries, and not less than one hour in mercantile establishments, mills or workshops, of which one hour at least, either at the same time or at different times, shall be before three o'clock in the afternoon in factories, mechanical establishments and laundries; and three-quarters of an hour at least, either at the same time or at different times, shall be before three o'clock in the afternoon in mercantile establishments, mills or workshops; and

(b) On Saturday not less than three-quarters of an hour in factories and laundries; and not less than half an hour in mercantile establishments, mills or workshops; and

(c) The proprietor, manager or other competent authority of any factory, laundry, mercantile establishment, mill or workshop, may arrange the time or times for meals as to the said employees as he sees fit; provided, however, that such arrangements as to such time or times for meals shall not conflict in any manner with any of the provisions of this Act; and

(d)[39] A woman, young person, or young person under the age of sixteen years shall not, during any part of the time or times allowed for meals in a factory, mercantile establishment, mill or workshop, be employed therein nor be allowed to remain in a room therein, in which a manufacturing process or handicraft is then being carried on,[39] but this provision shall not apply to those employees belonging to the classes herein named, whose presence during meal hours may be necessary for

[37] 2 Butt., *Twent. Cent. Stats.*, p. 124, *Fact. and Work. Act*, 1901, Pt. II, (i) sub-sec. (6) of Sec. 24.

[38] As to times for meals, see 2 Butt., p. 128, Sec. 33 of the English Act, 1901. language and ideas mainly followed.

[39] English Act, 2 Butt., *Twent. Cent. Stats.*, p. 132, Pt. II, s. h. (i), sub-sec. (2) of Sec. 40.

the proper conduct of the business in a factory, mercantile establishment, mill or workshop;[40] nor shall it apply to iron mills or paper mills or glass works, except in any part in which the materials are mixed and, in case of glass works in which flint glass is made, any part in which the work of grinding, cutting or polishing is carried on, or to letter press printing works.[41]

Section 17. A woman, young person, or young person under the age of sixteen years shall not, except as is in this Act specially excepted, be employed on a Sunday, in a factory, mechanical establishment, mercantile establishment, mill or workshop.[42]

Section 18. (1) Subject to any special exceptions made by or pursuant to this Act, the owner, proprietor, manager or other competent authority thereof, shall allow in each year, to every woman, young person, and young person under sixteen years of age employed in the factory, mercantile establishment, mill or workshop, of which he is such owner, proprietor, manager or other competent authority thereof, the following holidays:

(a)[43] As whole holidays the first day of January, commonly called New Year's Day, the 12th day of February, the 22d day of February, the 30th day of May, the 4th day of July, the first Monday in September, or Labor Day, the 12th day of October, commonly called Columbus Day, the 25th day of December, or Christmas Day, and any day appointed or recommended by the Governor of this State or by the President of the United States, as a day of fast or thanksgiving. When any holiday falls on a Sunday, it shall be allowed to the employee of any factory, mercantile establishment, mill or workshop, on the next preceding Saturday or the next following Monday, as the owner, proprietor, manager or other competent authority thereof shall determine; and

(b)[44] As half holidays, all Saturdays, except when anyone of the before named whole holidays falls on a Saturday, which shall in such case be a whole holiday, from the hour of twelve o'clock noon or of one o'clock, or of two o'clock in the afternoon, according as the period of employment on Saturday ends in any factory, mercantile establishment, mill or workshop at twelve o'clock noon, or at one o'clock, or at two o'clock in the afternoon, as provided in sub-section forty-five of section thirty of this Act. The term "half holidays" includes the period from twelve o'clock noon, or one o'clock, or two o'clock in the afternoon, as the case may be, according to the time when the period of employment ends as herein provided, until midnight of each Saturday that is not a holiday.

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[40] Act for Health, etc., of Employees, 1909, Hurd's *Rev. Stats. Ill.*, 1909, p. 1103, c. 48, Sec. 96, the proviso in the last sentence of that section.

[41] English Act, as cited in the last note but one preceding, sub-section (1).

[42] Adapted from the English Act, 2 Butt., p. 129, sub-sec. (1) of Sec. 35, Pt. II, (i).

[43] The list of Holidays here given is taken from the Act on Negotiable Instruments, 1874, Hurd's *Rev. Stats. Ill.*, 1909, p. 1532, c. 98, Sec. 17, as Amended by Act. of 1909.

[44] The English Act somewhat changed. See Butt., p. 130, Pt. (ii), Sec. 36.

Section 19.[45] In case the customs or exigencies of the trade or business carried on in any factory, mercantile establishment, mill or workshop, either generally or in any particular locality, require another day in the week to be substituted for Saturday as regards the hours at which the period of employment for women, young persons, and young persons under the age of sixteen years are required by this Act to end on Saturday, such other day may be substituted for Saturday; and in that case this Act shall apply in that factory, mercantile establishment, mill or workshop, in like manner as if the substituted day were Saturday, and Saturday an ordinary work day.

(iii) Night Work.

Section 20. (1)[46] A woman or a young person may be employed during the night in any factory, mechanical establishment, laundry, mercantile establishment, mill or workshop, but only in accordance with the following conditions:

(a) The period of employment must not exceed ten consecutive hours and must begin and end as follows: Such period may begin at six o'clock in the evening and end at four o'clock on the following morning; or begin at seven o'clock in the evening and end at five o'clock on the following morning; or begin at eight o'clock in the evening and end at six o'clock on the following morning; as the owner, proprietor, manager or other competent authority of such factory, laundry, mercantile establishment, mill or workshop shall determine; and

(b) The provisions of Part II of this Act, as to allowance for times of meals, shall be observed, with the necessary modifications as to the hour at which the meal times are fixed; and

(c) A woman or young person employed during any part of the night must not be employed during any part of the twelve hours preceding or succeeding the period of employment, except that in the case of a woman she may agree, in writing as hereinbefore provided, for a longer period of employment than said ten hours; and

(d)[47] Such woman or such young person must not be employed more than five nights in any week throughout the year; provided, however, that this condition shall not prevent the employment of male young persons in three shifts of not more than eight hours each, if there is an interval of two unemployed shifts between each two shifts of employment; and

(e) In case of blast furnaces, iron mills, letter press printing works, and paper mills, no male young person must be employed during the night, or any part thereof, in any process other than a process incidental to the business of the factory or place of work.

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[45] Idea from the English Act, but much changed—Albert J. Norton.

[46] The general idea of this sub-section including (a), (b), (c), is taken from the English Act, but not any provisions specifically.

[47] The provisions of the English Act are followed in the main in (d), (e), sub-section (2) and sub-section (3) of Sec. 54, Pt. II., sub-section (1), (a), (b), (c), (d) and (e) p. 138, and sub-section (3), p. 139, of 2 Butt., *Twent. Cent. Stats.*

(2) The provisions of this Act, as to period of employment on Saturday and as to allowance of whole and of half holidays to women and young persons, shall not apply to a male young person employed in day and night turns in pursuance of this exception.

(3) This exception applies to the following factories:

(a) Blast furnaces,

(b) Iron mills,

(c) Letter press printing works, and

(d) Paper mills.

Section 21.[48] In a factory or other place in which the printing of newspapers is carried on, a male young person may be employed at night not more than two nights in a week as if he were no longer a young person, but must not, pursuant to this Act, be employed more than ten hours in any consecutive period of twenty-four hours.

Section 22.[49] (1) The owner, proprietor, manager or other competent authority of the factory, mercantile establishment, mill or workshop in which females are employed, shall provide a sufficient number of suitable seats for the use of such female employees, and shall permit such female employees to use such seats at all times when their use will not necessarily interfere with the proper discharge of the duties of such employees, and where practicable, such seats shall be made a permanent fixture and shall be so constructed or adjusted that when not in use they will not obstruct such female employees while engaged in their duties. Each female employee must be permitted to use a seat for a sufficient length of time or a sufficient number of times in each period of employment to prevent injury to her health, so far as the use of a seat as herein provided will contribute to that end.

(2)[50] Chairs, stools or other suitable seats shall be maintained in mercantile establishments for the use of the female employees therein, in accordance with the terms of the preceding sub-section, and their use shall be allowed to such employees in accordance with the terms of that sub-section; if the duties of the female employees for whom the seats are furnished are principally to be performed in front of the counter, table, desk or fixture, such seats shall be placed in front thereof; if such duties are principally to be performed behind such counter, table, desk or fixture, such seats shall be placed behind the same.

Section 23.[51] In every factory, mercantile establishment, mill or workshop a printed notice, or printed notices, showing the following particulars shall be kept posted up in conspicuous places therein, and

[48] 2 Butts., *Twent. Cent. Stats.*, p. 139, *Fact. and Work. Act*, 1901, Pt. II (ii), Sec. 56.

[49] Health, etc., Act of 1909, Hurd's *Rev. Stats., Ill.*, 1909, p. 1104, c. 48, Sec. 97, nearly *verbatim*.

[50] *Rev. Stats.*, N. Y., 1901, Art. XI, *Labor*, Sec. 170; as to seats for female employees in a factory, hotel or restaurant see *ibid.*, Art. I, *Labor*, p. 2053.

[51] This notice might perhaps contain an abstract of the important provisions of this part of the Act.—Albert J. Norton.

where they can easily be read by the employees thereof, namely, a notice or notices of:

I. The period of employment in a factory, mercantile establishment, mill or workshop, including that of Saturday; and

II. The hour when such period of employment begins and the hour when it ends on all work days, including the hours on Saturday; and

III. The length of time allowed to the employees for meals and the time or times fixed for meals in that factory, mercantile establishment, mill or workshop during the period of employment; and

IV. A list of the whole holidays named in this part of the Act, and notice of the half holidays on Saturdays or any day substituted for Saturday; and

V. The period of employment in case of night work; and

VI. The hour when the period of employment begins and when it ends; and

VII. The length of time allowed to any employee for meals and the time or times fixed for meals during the period of employment; and

VIII. The number of nights in a week that such employees shall be allowed to work.

Section 24. A factory, mercantile establishment, mill or workshop in which there is a violation of any of the provisions contained in any of the preceding sections in this part of the Act, shall be deemed not to be kept in conformity with this Act.

(*IV*) *Fitness for Employment.*

Section 25.[52] No owner, proprietor, manager or other competent authority of any factory, mercantile establishment, mill or workshop shall knowingly employ a female or allow a female to be employed therein within four weeks after she has given birth to a child.

Section 26.[53] (1) No young person under the age of sixteen years, as defined in this Act, shall be employed or permitted to work in any factory, mercantile establishment, mill or workshop, store, office, laundry, bowling alley, theatre, concert hall, or place of amusement, passenger or freight elevator, telegraph office or similar place, or as a messenger or driver of or for any of the before named establishments or working places for more than seven days, or, if the certifying physician, provided for in this Act, for the district in which such establishment or working place is situated, resides more than three miles from such establishment

[52] Butts, *Twent. Cent. Stats*, p. 142, *Fact. and Work. Act*, 1901, Part II, (iii), Sec. 61. Language of the English Act, adapted to conditions here.

[53] Partly from the English Act and partly from the child labor law of 1903. For the former see Sec. 63, sub section (1), p. 142, as in the preceding note; and for the latter see Hurd's *Rev. Stats. Ill.*, 1909, p. 1079, Sec. 2.

or working place, twelve days; unless either within or at once upon the termination of the one or of the other of the periods just named, as the case may be, the owner, proprietor, manager or other competent authority of such establishment or working place has obtained a certificate, in the prescribed form, of the fitness of the young person under the age of sixteen years for employment in that establishment or working place.

(2) When a young person under the age of sixteen years becomes a young person as defined in this Act, a fresh certificate of fitness must be obtained.

Section 27.[54] With respect to a certificate of fitness for employment the following provisions shall have effect:—

(1) The certificate shall be granted by the certifying physician for the district.

(2) The certificate must not be granted except upon personal examination of the person therein named.

(3) The certifying physician shall not examine a young person under the age of sixteen years elsewhere than at the establishment or working place where the said young person is about to be employed, unless the number of young persons under the age of sixteen years employed in that establishment or working place is less than five, or unless for some proper special reason allowed in writing by an inspector or by a medical inspector.

(4) The certificate shall be to the effect that the certifying physician is satisfied by the production of a certificate of birth or of any other certificate now provided by law, showing among other things the birth of the said young person in question, or by any other sufficient evidence, that the person named in the certificate is of the age therein certified, and has been personally examined by him and is not incapacitated by disease or bodily infirmity for working daily during the time allowed by law in the establishment or working place named in the certificate.

(5) The certificate may be qualified by conditions as to the work on or at which a young person under the age of sixteen years is fit to be employed, and, if so qualified, the owner, proprietor, manager or other competent authority of the establishment or working place in which it is proposed to employ the person named in the certificate, shall not employ that young person otherwise than in accordance with the conditions therein; provided, however, that the said conditions must not in any manner conflict either with the letter or the spirit of this Act or of any of its provisions.

(6) A certifying physician shall have the same powers that an inspector, or a medical inspector has, under this Act, or under any law now existing for the purpose of examining any process in which a young person under the age of sixteen years presented to him for the grant of a certificate is proposed to be employed.

[54] Sub-sections (1)–(7) of this section are copies of the English Act, except as modified to adapt them to conditions here. See pp. 142, 143, 2 Butt., as before, Sec. 64, sub-sections (1)–(7).

(7) All establishments or working places named in sections forty-one and in this section belonging to the same owner or proprietor or under the control of the same manager or other competent authority thereof, or any of them, and in the district of the certifying physician, may be named in the certificate, if the physician is of the opinion that he can truthfully give the certificate of fitness for employment therein.

(8)[55] In case the certificate is to the effect that the certifying physician has been satisfied regarding the age of a young person under the age of sixteen by evidence other than the production of the certificate of birth or of any other certificate showing the birth of the said young person, as provided in sub-section four of this section, an inspector or a medical inspector may, by notice in writing to the person or authority employing such young person, annul the certifying physician's certificate, if he or she has reasonable cause to believe that the real age of the young person under the age of sixteen years named in the certificate is less than that named therein.

(9)[56] In case a certifying physician refuses to grant a certificate of fitness for employment for any person examined by such physician, he or she shall, when required, state in writing and sign the reasons for such refusal.

Section 28.[57] In case an inspector or a medical inspector is of the opinion that a young person under the age of sixteen years is by reason of disease or bodily infirmity incapacitated for working daily for the time allowed by law in the establishment or working place, coming under one class or more than one of the classes named in sections twenty-six and twenty-seven, in which such young person under the age of sixteen years is employed, he or she may serve written notice thereof on the owner, proprietor, manager or other competent authority of such establishment, or establishments, or working place or working places, requiring that the employment of such young person under the age of sixteen years shall be discontinued from the period named therein, such period to be not less than one nor more than seven days after the service of the notice, and the employment of such young person under the age of sixteen years shall be so discontinued, notwithstanding the fact that a certificate of fitness for employment has previously been obtained, unless the certifying physician for the district shall, after the service of the notice, personally examine the young person in question and shall certify that such young person under the age of sixteen is not so incapacitated.

Section 29.[58] It shall be the duty of every owner, proprietor, manager or other competent authority of every factory, mercantile establishment, mill or workshop, store, hotel, office, laundry, bowling alley, theatre, concert hall or other place of amusement, passenger or freight elevator,

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[55] Made up of provisions from the English Act and from the child labor law of 1903. See Sec. 67, pp. 144, 145, of 2 Butt., as before; and Hurd's *Rev. Stats. Ill.*, 1909, p. 1079, c. 48, Sec. 20c.

[56] This is Sec. 64, sub-section (10), p. 144, 2 Butt., as before cited.

[57] This is Sec. 67, p. 144, as in the preceding note, of the English Act.

[58] Child Labor law of 1903, Hurd's *Rev. Stats. Ill.*, p. 1079, c. 48, Sec. 20c.

telegraph office or similar place, that employs young persons under the age of sixteen years therein or as messengers or drivers of or for such establishment or working place, to keep a register in such factory, mercantile establishment, mill, workshop, store, hotel, office, laundry, bowling alley, theatre, concert hall or place of amusement, passenger or freight elevator, telegraph office or similar place in which such young persons under the age of sixteen years are employed or permitted to work, in which register shall be recorded the name, age and place of residence of every such young person under the age of sixteen years employed or permitted to work therein, or as messenger or driver of or for such establishment or working place; and it shall be unlawful for any owner, proprietor, manager or other competent authority of any factory, mercantile establishment, mill, workshop, store, hotel, office, laundry, bowling alley, theatre, concert hall or place of amusement, passenger or freight elevator, telegraph office or similar place, to employ or permit to be employed therein, or as messenger or driver of or for any such establishment or working place, any young person under the age of sixteen years, unless there is first procured and placed on file in such factory, mercantile establishment, mill, workshop, store, hotel, office, laundry, bowling alley, theatre, concert hall or place of amusement, passenger or freight elevator, telegraph office or similar place, an age and school certificate as is now provided for by law.

Section 30.[59] Every owner, proprietor, manager or other competent authority of any factory, mercantile establishment, mill or workshop, store, hotel, office, laundry, bowling alley, theatre, concert hall or place of amusement, passenger or freight elevator, telegraph office or similar place, that employs or permits to be employed or to work therein five or more young persons under the age of sixteen years, shall post and keep posted in a conspicuous place in every room thereof in which such young person under the age of sixteen years is employed or permitted to work, a list containing the name, age, and place of residence of every young person under the age of sixteen years employed or permitted to work in such room.

Section 31.[60] The presence of any young person under the age of sixteen years in any establishment named in the next preceding section, except in cases in which such young person is evidently there for another purpose, shall be *prima facie* evidence of his or her employment therein.

Section 32. A factory, mercantile establishment, mill, workshop, store, hotel, office, laundry, bowling alley, theatre, concert hall or place of amusement, passenger or freight elevator, telegraph office or similar place, in which there is a violation of any of the provisions contained in any of the preceding sections numbered twenty-six, twenty-seven, twenty-eight, twenty-nine, thirty, thirty-one and thirty-two contained in this part of the Act, shall be deemed not to be kept in conformity with this Act.

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[59] Hurd's *Rev. Stats. Ill.*, 1909, p. 1079, c. 48, Sec. 20c.
[60] Hurd's *Rev. Stats. Ill.*, 1909, p. 1082, c. 48, Sec. 20k.

PART III.[62]

Dangerous and Unhealthful Conditions.

(*i*) *Special Provisions.*

Section 33.[63] (1) Every medical practitioner attending on or called in to visit a patient that he believes to be suffering from lead, phosphorous, arsenical or mercurial poisoning, or anthrax, poisonous fumes or vapors, gassing or other similar disease contracted in any factory, mercantile establishment, mill or workshop, commercial institution, or other establishment or working place, or from what is known as the "caisson-disease" contracted in tunnelling or other employment in which caisson work is performed, shall, unless the notice required by this subsection has previously been sent, send to the Department of.....at its main office or at such other office or place as the Department shall designate for the purpose, a notice stating the name and full postal address of the patient and the disease from which, in the opinion of the medical practitioner, the patient is suffering, together with all the attending circumstances of the case; and such medical practitioner shall be paid such a fee or compensation for his services in that respect as shall hereafter be provided by law, such fee or compensation to be paid as part of the expenses incurred by the Department in the execution of this Act.

(2)[64] The provision of subsection (1) of this section as to reporting the cases named therein and as to notice and other requirements, shall apply to every hospital, medical college, or other institution having such patient or suspecting that it has such a patient, and to every owner, proprietor, manager or other competent authority of any factory, mercantile establishment, mill or workshop, commercial institution, or other establishment or working place, and to every contractor and every subcontractor engaged in tunnelling or other kinds of work in which caisson work is carried on.

(3)[64] Written notice of every case of lead, phosphorous, arsenical, or mercurial poisoning, of anthrax, of every case resulting from poisonous fumes or vapors, of gassing, or other similar disease contracted in any factory or other place named in subsection (1) of this section, or of the caisson disease contracted as aforesaid, shall forthwith be sent to the medical inspector and to the certifying physician for the district in which the factory or other place mentioned in subsection (1) of this section is located.

(4)[64] If any medical practitioner, employer, contractor or subcontractor, hospital, medical college, or other institution named in subsections (1) and (2) of this section, when required by this section to send notice, fails forthwith to send the same, he or it shall be liable to a fine not exceeding twenty-five dollars.

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[62] Part III here corresponds to Part IV and Part V of the English Factory and Workshop Act of 1901.

[63] See 2 Butt., *Twent. Cent. Stats*, p. 147, *Factory and Workshop Act*. 1901, Part IV., (i) *Special Provisions*, Sec. 73 (1).

[64] Provisions similar to those of English Act, sub-sections (3), (2), of Sec. 73, p. 148, 2 Butt., etc.

Section 34.[66] (1) In every factory, mercantile establishment, mill or workshop, commercial institution, or other establishment or working place, or any part thereof, in which any kinds of lead, arsenic, phosphorous, irritating and poisonous acids, irritating and poisonous cyanides, or any other irritating and poisonous substance is used, and in which metallic fumes or vapors, carbon monoxide fumes or vapors, lead fumes or vapors, cyanide fumes or vapors, and shellac fumes or vapors, or any other poisonous fumes or vapors are generated from substances used therein or any part thereof, suitable washing conveniences must be provided for the use of employees in any department thereof where such substances are used and such fumes or vapors are generated; and sufficient time must be allowed such employees for washing and for changing clothing when necessary.

(2)[67] No employee shall take or be allowed to take food into any room or apartment in any factory, mercantile establishment, mill or workshop, commercial institution, or other establishment or working place where lead, arsenic, or other poisonous substances, or injurious or noxious fumes, dust or gases under harmful conditions are present, as the result of the business conducted by such factory, mercantile establishment, mill or workshop, commercial institution, or other establishment or working place, and notice to this effect shall be posted in each room or apartment. The employees shall not remain in any such room or apartment during the time allowed for meals, and suitable provisions shall be made and maintained by the employer, when practicable, to enable the employees to take their meals elsewhere in such establishment: *Provided,* however, that this section shall not apply to those employees whose presence during noon hour is necessary for the proper conduct of the business.

Section 35.[68] (1) In all iron, lead, zinc, brass, copper, and other foundries in which ores are smelted to produce iron, lead, zinc, brass or copper, no open-top furnace nor single-top furnace shall be constructed after this Act takes effect; and in all blast furnaces constructed after this Act takes effect, no open-top furnace and single-top furnace, or either, shall be constructed and used.

(2) In all those blast furnaces belonging to the foundries named in subsection (1) of this section in which open-top furnaces and bell-top furnaces, or those of either kind alone, are at present in use, when it becomes necessary or is desired to construct new furnaces after this Act takes effect, such new furnaces must be provided with automatic top-chargers, and after such automatic top-chargers have been thus provided, no manual loading-in or charging at the top of such furnaces shall be permitted.

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[67] Act to Provide for Health, etc., of Employes, 1909, Hurd's *Rev. Stats. Ill.*, 1909, p. 1103, Sec. 91.

[68] The provisions of this section were prepared from suggestions made by Mathew Karasek, M. D., Chicago, Ill.

Section 36.[69] (1) The following provisions relating to the health of the employees in iron, lead, zinc, brass, copper and other similar foundries are to be strictly observed by employers:—

(a) Suitable hoods, stack and apron around the furnace area must be provided for each furnace; and the furnace room must be separate from the remainder of the foundry. Ceiling ventilators effective in inclement weather must be provided. These precautions must be taken for the purpose of disposing of all metallic, carbon monoxide, and other noxious and poisonous fumes or vapors. No anemic or sickly person shall be employed in any part of a foundry where such noxious and poisonous vapors are generated.

(b) In all such foundries and those parts thereof in which lead fumes are generated or lead is found in dust, alloys, and other similar substances, all scrap metal shall be sprinkled before it is handled or assorted. The employer must, without cost to the employees or any of them, provide respirators and gloves for all employees affected by such dust. The certifying physician of the district in which such foundry is situated shall once every month examine the employees of such a factory for the purpose of ascertaining whether any of them show symptoms of lead poisoning. No woman and no young person shall be employed in any part of such foundries in which the fumes and the poisonous substances, and the impurities mentioned in this section are generated or found. No young person under the age of sixteen years and no child shall be employed in any such foundry. No anemic or sickly person shall be employed in any such foundry.

(c) Fumes or vapors arising from castings dipped into acids must be disposed of by means of suitable hoods and a suction fan or other proper device for carrying off said fumes or vapors.

(d) In the case of hot potash solutions, fumes or vapors arising therefrom must be disposed of by means of

(e) a low-hung hood or hoods with connection with stack and suspended over vats. This provision shall apply to cyanide solutions used in such foundry.

(f) No worker in such foundry shall be required to "do" in one day a greater number of standard flasks or other like articles than he can do without injury to his health.

(g) Suitable facilities for washing shall be furnished in every such foundry, and workers therein shall be allowed ten minutes to wash before meal time. Shower baths shall be furnished to furnace men, smelters, and other similar workers.

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[69] The provisions of this section and of the following section were drafted from a report made by Emory R. Hayhurst, M. D., Chicago, Ill., to the Commission.

The provisions of this and the three sections immediately following, especially the prohibitions therein against employing women, young persons, and young persons under the age of sixteen in the places named, have the approval of Mr. S. M. Hartzmann, Chicago, who is familiar with the subjects dealt with in those sections.

(h) Suitable and sanitary provisions shall be made for toilet rooms separate from work rooms in every such foundry.

(i) In every such foundry an even temperature in the winter season of at least fifty degrees Fahrenheit shall be maintained.

(j) There must be kept posted in every room where workers are employed in any brass foundry instructions as to how to treat "brass founders ague."

(k) In every foundry named in this section one hour shall be allowed the employees for the noon meal, and in those foundries where night work is carried on, one hour at a suitable time during the night.

Section 37. (1) In every factory or other working place mentioned in subsection (1) of section 36, when it is necessary for the health and protection of the employees thereof or of any of them that rubber gloves, goggles and other means of protection, or of any of them, should be used, such articles for the protection of the employees therein, or of any of them, shall be furnished the employees or any of them by their employers, as may be necessary, without cost to the employees.

Section 38. (1) Any factory, mercantile establishment, mill or workshop, commercial institution, or other establishment, foundry, or working place in which there is a violation of the provisions or any of them of sections 49, 50, 51 and 52, shall be deemed not to be kept in conformity with this Act, and the owner, proprietor, manager, or other competent authority thereof shall be fined in a sum not exceeding twenty-five dollars for a first offence and a sum not exceeding twenty-five dollars for every subsequent offence.

Section 39.[70] (1) No woman, young person, or young person under the age of sixteen years shall be employed in the part of a factory, mercantile establishment, mill or workshop, commercial institution, or other establishment or working place in which is carried on:—

(a) The business of silvering mirrors by the mercurial process; or

(b) The process of making white lead or other kind of poisonous lead, or other process in which poisonous substances are used; or

(c) In the part of a factory in which the process of melting or annealing glass is carried on; or

(d) In a factory or other establishment or working place in which is carried on the making or finishing of brick or tiles, not being ornamental; or

(e) In the part of a factory or other establishment or working place in which is carried on any dry grinding in the metal trades; or

[70] The English Act, 2 Butt., etc., p. 149, Pt. IV, Sec. 77, embodied in (a), (b), (c), (d), (e), (g), (h), and suggestions from Dr. Hayhurst's report in (f).

(f) In the case of brass works, in any part in which the materials are mixed; and in brass and other foundries, in those parts thereof where poisonous substances are used or noxious or poisonous fumes or vapors are generated; or

(g) In the case of glass works where flint glass is made, in any part in which the work of grinding, cutting, or polishing is carried on; or

(h) In the case of earthenware works, in any part known or used as dippers house, dippers drying room, or china scouring room; and

(i) No woman or female young person employed in any factory, laundry, mercantile establishment, mill or workshop, commercial institution, or other establishment, or working place, shall be permitted to work at a machine or other mechanical device that requires her to stand constantly during the period of employment on her feet and to operate such machine or device with one foot.

(2) Any violation of the provisions of this section in any factory, laundry, mercantile establishment, mill or workshop, commercial institution, or other establishment or working place, or any part thereof, shall cause the same to be deemed not to be kept in conformity with this Act; and for every violation thereof, the owner, proprietor, manager or other competent authority thereof shall be liable to a fine not exceeding twenty-five dollars for each offence.

(3) Notice of the prohibitions in this section shall be affixed in every factory, mill or workshop, commercial institution or other working place to which it applies.

(*ii*) *Bakeries.*

Section 40.[71] (1) It shall not be lawful to let or suffer to be occupied or to occupy any room or place as a bakery, unless the following regulations are complied with:—

(a) No water closet, earth closet, privy, urinal, or ashpit shall be within or communicate directly with any part of a bakery where baking is done, flour and other articles stored, or where bakery goods are kept for sale.

(b) Every cistern or other similar means for supplying water to any bakery must be separate and apart from any cistern or any other means for supplying water to a water closet, earth closet, privy, or urinal.

(c) A drain or drains or a pipe or pipes for carrying off fœcal matter or sewage must not have an opening within any part or room of a bakery where baking is done, flour and other articles stored, or where bakery goods are kept for sale.

[71] This section is copied from the English Act, 2 Butt., p. 156, Part V, (iii), Sec. 97.

(2) If any person lets or suffers to be occupied or occupies any room or place as a bakery in violation of this section he shall be liable to a fine not exceeding twenty-five dollars; and to a further fine not exceeding five dollars for every day during which any room or place is so occupied after a conviction under this section.

Section 41.[72] (1) The owner of the building and premises, or either on or in which any factory, mercantile establishment, mill or workshop, commercial institution, or other establishment or working place is situated, as well as the proprietor, manager or other competent authority thereof, shall be liable for the observance and fined for the non-observance of the provisions of this Act, of the following character:—

(a) Cleanliness, freedom from effluvia, overcrowding and ventilation of factories, mercantile establishments, mills or workshops, commercial institutions, or other working places, provided for in section one of this Act, including so far as they relate to any engine house, passage, or staircase, or to any room that is let to more than one tenant, the provisions as to lime washing and washing of the interior of the factory, mercantile establishment, mill or workshop, commercial institution, or other working place; and

(b) The notices to be affixed in a factory, mercantile establishment, mill or workshop, commercial institution, or other working place, with respect to the period of employment, times for meals, and system of employment for women, young persons, and young persons under the age of sixteen years; and

(c) The prevention of the inhalation of dust, gas, fumes or vapors or other impurities, so far as those provisions require the use of pipes or other contrivances for working the fans or other means for that purpose.

PART IV.

Administration.

(*i*)[73] *State Department of* .....

Section 42. In order the better to carry out the purposes of this Act, the Governor, by and with the advice and consent of the Senate, within

[72] See 2 Butt., p. 152, Pt. IV (ii), Secs. 85, 86, for the provisions of this section, but considerably modified.

In Part III might well be inserted provisions regulating employment in laundries, ice-cream and butterine factories, and in many other trades. As to laundries, the Factory and Workshop Act of 1907, amending that of 1901, found in 2 Butt., *Twent. Cent. Stats.*, pp. 209-213, could be consulted with advantage.

[73] The State administrative authority might be constituted as a department, board, commission, etc., as should seem desirable to the legislative body creating it.

Sections 42, 43, 44, 45 and 46 follow quite closely Section 4 (A), (B), (E), (F), 1, 2, and Section 5 (A), (B) of an Act to revise the laws relating to charities, etc., 1909, found in Hurd's *Rev. Stats. Ill.*, pp. 259-264, c. 23, sections 5 and 6.

thirty days after this Act shall take effect, shall appoint five persons, to be called and known as the Department of ....., and hereinafter called Department. One member shall be Chief of the Department, one member shall be a woman, one member shall be an employer of labor, one member shall be a manual laborer, and one member shall be a duly licensed physician, in good and regular standing, who shall be a specialist in Industrial Hygiene. Not more than three persons so appointed shall belong to the same political party. The members shall be appointed: One for one year; one for two years; one for three years; one for four years; and one for five years, from the first day of July, 1911, and until their respective successors are appointed and qualify. On the first day of July, 1912, and at the end of each year thereafter, the Governor shall, in like manner, appoint one person as the successor of the person whose term shall expire in that year, to serve as such member of the Department of Labor, for five years, and until his or her successor is appointed and qualifies. Each member before entering upon the duties of his or her office shall take the oath prescribed by the Constitution of this State for State officers, which oath shall be filed in the office of the Secretary of State. The Governor shall have the power to remove any member of the Department, and the power to appoint and to remove the Assistant Chief of the Department, and the Attorney for the Department, hereinafter provided for, for incompetency, neglect of duty or malfeasance in office. In case of a vacancy in the Department, the vacancy shall be filled by appointment by the Governor, by and with the advice and consent of the Senate. When the Senate is not in session, the Governor may make appointments to fill vacancies, but all appointments when the Senate is in session shall be subject to confirmation by the Senate at its next session before becoming permanent.

Section 43. The Governor shall at the time he appoints the members of the Department, and from time to time thereafter, designate a member, who shall be called Chief of the Department. The Chief of the Department shall devote his whole time to the duties of his office, and shall receive such compensation therefor as shall hereafter be provided by law. The other members of the Department shall serve without compensation, except that they shall be paid per diem expenses during the time of their actual attendance upon meetings of the Department. Three members of the Department shall constitute a quorum.

Section 44. The Secretary of State shall provide the Department with suitably furnished offices in the Capitol building at Spring- Labor with suitably furnished offices in the Capitol building at Springfield. The Department shall have an official seal. Every process, order, or other paper issued or executed by the Department, may be attested, by direction of the Department, under its seal, by its Secretary, and when so executed shall be deemed to be duly executed by the Department.

Section 45. (1) The Department herein provided for shall:

(a) Be a body corporate under and by the name of the State Department of ....., and, in addition to the powers expressly conferred upon it, shall have all

such authority as may be necessary to the complete exercise thereof; and

(b) Exercise executive and administrative supervision over all State and local authorities whose functions have to do with the matters of health, safety and comfort of workers, especially as related to the public health and welfare; and

(c) Exercise general, executive and administrative supervision over factory inspection and the inspection of mines, and shall secure the execution of all laws now in force or hereafter enacted, relating to the inspection of factories, mercantile establishments, mills or workshops, commercial institutions, and other working places as each is defined in this Act, and of mines.

(2) Until the Department enters upon its work as herein provided, on the first day of July, 1911, the Illinois Department of Factory Inspection and the Chief State Factory Inspector and his assistants and all the officers and agents and employees of that Department shall have the powers and perform the duties devolving upon them under the existing laws as therein provided.

(3) The Chief of the Department shall by virtue of his office be Chief State Factory Inspector; and after the Department enters upon its duties as aforesaid, wherever the words "Chief State Factory Inspector" occur in this Act, they shall be construed to mean the Chief of the State Department.

Section 46. The Governor shall at the time that he appoints the Chief of the Department, and from time to time thereafter, appoint an Assistant Chief of the Department, who shall also act as and perform the duties of Secretary of the Department; and the Governor shall at the same time and from time to time thereafter also appoint an Attorney for the Department.

Section 47. (1) The Chief of the Department shall have the power to appoint and to remove ..... Deputy Factory Inspectors, hereinafter called Deputy Inspectors, and ..... Deputy Medical Factory Inspectors, hereinafter called Medical Inspectors. Of the ..... deputy inspectors, ... shall be women, and of the ..... medical inspectors, ... shall be women; and

(2) All deputy inspectors herein provided for shall be appointed and removed under and subject to the provisions of "An Act to regulate the Civil Service of the State of Illinois," approved May 11, 1905, and in force July 9, 1905, as amended.[74] The Assistant Chief of the Department, the Attorney, the deputy inspectors and the medical inspectors shall receive such compensation for their services as shall hereafter be provided by law.

[74] Board of Charities Act, 1909, Hurd's *Rev. Stats. Ill.*, 1909, c. 23, Sec. 12, p. 266.

(3)[75] The Chief of the Department shall as soon as convenient after he enters upon the duties of his office divide the State into Inspection Districts, due regard being had to the number of factories, workshops and other business establishments named in this Act and the amount of work to be performed in each district. He shall assign to each district a deputy inspector, who shall have charge of the inspection in the district to which he is assigned, under the supervision of the Department; and shall assign to one district or to a group of districts, as he may deem best, a medical inspector. The Chief of the Department may at any time, when in his opinion the good of the service requires, change a deputy inspector or a medical inspector from one district to another, or reassign the districts of the State among the several deputy inspectors. He may at any time, when the conditions are changed or in his opinion the service requires, redivide the State into Inspection Districts, changing the territory embraced within the several districts as may seem to him advisable; but all of his acts in these respects shall be subject to the approval of the Department.

(4) The Chief of the Department shall also have the power to employ such other officers, agents and servants as he may deem necessary for the efficient conduct of the business of the Department, and shall assign to them their duties and fix their salaries.

Section 48. The Attorney for the Department shall be the legal adviser of and shall represent the Department in all matters of a legal nature pertaining to the business of the Department, and shall perform all of the other duties of the office incident thereto. He shall when required by the Department prosecute any violations of law that it is the duty of the deputy inspectors and the medical inspectors to enforce. He shall under the direction of the Chief and subject to the approval of the Department prepare all forms, notices, and other papers of a legal nature.

(ii) *Inspection.*

Section 49.[76] (1) The Chief of the Department, the Assistant Deputy Chief, the deputy inspectors and the medical inspectors shall have the power to perform and shall perform any or all of the following acts:—

(a) To enter and inspect at all reasonable hours by day all of the factories, mercantile establishments, commercial institutions, mills or workshops and every part thereof in which wares, goods, merchandise, or other articles are manufactured, stored, purchased or sold at wholesale or retail, and all other establishments or working places mentioned in this Act: *Provided,* that whenever any secret process is used in any of the establishments or working places covered in the provisions of this Act, the owner, proprietor, manager, or other

[75] Sub-section (3) follows closely portions of Sec. 77, c. 48, p. 1097, Factory Inspection Act, 1907, Hurd's *Rev. Stats. Ill.*, 1909.

[76] Sub-section (1) (a) consists of portions of the Factory Inspection Act of 1907, Hurd's *Rev. Stats. Ill.*, p. 1097, Sec. 77, and of Act of 1909 for the Health of Employees, *Ibid.*, p. 1107, Sec. 113.

competent authority thereof shall, whenever required by the Chief or the Assistant Chief of the Department, file with the Department an affidavit that such owner, proprietor, manager, or other competent authority has in all respects complied with the provisions of this Act. Such affidavit shall be accepted in place of the inspection of any room or apartment in which such secret process is carried on. The Chief, Assistant Deputy Chief, the deputy inspectors and the medical inspectors, shall have the same power to enter and inspect at all reasonable hours by night all or any of the establishments or places herein named in which night work is carried on that they have to enter and inspect them by day; and

(b)[77] To take with him or her in any case a constable or police officer into any establishments or working place named in (a) of sub-section (1) of this section in which he or she has reasonable cause to apprehend any serious obstruction to the execution of his or her duty; and

(c) To require the production of registers, certificates, notices and documents that are to be kept pursuant to this Act, and to inspect, examine and copy the same; and

(d) To make such examination and inquiry as may be necessary to ascertain whether the enactments in force relating to the public health and the other matters provided for in this Act are complied with, so far as respects the factory, mercantile establishment or commercial institution and the persons employed therein; and

(e) To enter any school in any factory, mercantile establishment, mill or workship or other establishment or working place in which he or she has reasonable cause to believe children are employed, and are, for the time, being educated; and

(f) To examine, either alone or in the presence of any other person, with respect to matters under this Act, every person that he finds in a factory, mercantile establishment, or commercial institution, mill or workshop, or other working place, or such school aforesaid, or that he or she has reasonable cause to believe to be or to have been within the preceding two months, employed therein, and to require every such person to be examined and to sign a declaration of the truth of the matters as to which of such persons are thus examined; and

(g) To exercise such other powers as may be necessary to carry this Act into effect.

(2) The owner, proprietor, manager or other competent authority of any factory, mercantile establishment, mill or workshop, commercial institution or other working place mentioned in this Act, shall furnish

[77] Sub-divisions (b), (c), (d), (e), (f), (g) of sub-section (1) and sub-section (2) are substantially copied from the English Factory and Workshop Act, 1901, 2 Butt., *Twent. Cent. Stats.*, pp. 171, 172, Sec. 119, sub-section (1) (b), (c), (d), (e), (f), (g) and sub-section (2) of *Part* VIII (i).

such means required by any inspector or medical inspector as may be necessary for any entry, inspection, examination, inquiry or other exercise of his or her powers and duties under this Act, in relation to any factory, mercantile establishment, mill or workshop, commercial institution or other establishment or working place mentioned in this Act.

(3)[78] If any person wilfully delays any inspector or medical inspector in the exercise of any power or duty under this section, or fails to comply with the requisition of any inspector or medical inspector pursuant to this section, or to produce any certificate or document required to be produced pursuant to this Act, or conceals or attempts to conceal, or prevents or attempts to prevent a woman, young person or child from appearing before or being examined by an inspector or a medical inspector, that person is to be deemed to obstruct an inspector or medical inspector in the execution of his or her duties under this Act:

Provided: that no one shall be required under this section to answer any questions or to give any evidence tending to incriminate himself or herself.

(4)[78] In case an inspector or a medical inspector is obstructed in the execution of his or her duties under this Act, the person obstructing him or her shall be liable to a fine not exceeding twenty-five dollars; and in case of any subsequent conviction for a similar offense, under this section, within two years from the last conviction for such offense, a fine of not less than twenty-five dollars shall be imposed for each offense.

Section 50.[79] An inspector or medical inspector, if so authorized in writing under the hand of the Chief of the Department, may, although he or she is not an attorney-at-law, prosecute, conduct or defend before a Justice of the Peace or other court of competent jurisdiction, an information, complaint, or other proceedings, arising under this Act or in the discharge of his or her duty as an inspector or medical inspector.

Section 51.[80] Every inspector and every medical inspector shall be furnished with the prescribed certificate of his or her appointment, and on applying for admission to a factory, mercantile establishment, mill or workshop, commercial institution or other working place mentioned in this Act, shall, if so required, produce said certificate to the owner, proprietor, manager, or other competent authority thereof.

(iii) *Certifying Physicians.*

Section 52.[81] (1) Subject to such regulations as may be made by the Department, the Chief of the Department may appoint for each of the inspection districts provided for in this Act such a number of duly licensed physicians, to be Certifying Physicians, for the purposes of this Act, as he may deem necessary for its proper execution, and may revoke such appointment.

(2) A physician, owner, proprietor, or manager of a factory, mercantile establishment, mill or workshop, commercial institution or other

[78] See last citation, p. 172, sub-sections (3) and (4).
[79] *Ibid.*, Sec. 120.
[80] *Ibid.*, Sec. 121.
[81] *Ibid.*, p. 173, (ii), Sec. 122, sub-sections (1), (3), (5) and (6).

establishment or working place mentioned in this Act, or other person, directly or indirectly interested therein or any process or business carried on therein, or in a patent connected therewith, shall not be a certifying physician for that factory, mercantile establishment, mill or workshop, commercial institution or other establishment or working place mentioned in this Act.

(3) Every certifying physician, if so directed by the Chief of the Department, shall make any special inquiry and re-examine any young person under the age of sixteen years, or any child, pursuant to this Act.

(4) Every certifying physician shall in each year, at a prescribed time or times, as directed by the Department of Labor, and in the form prescribed, make a report to the Department as to the persons inspected and the results of the inspection.

Section 53. Such fees or compensation shall be paid certifying physicians as shall hereafter be provided by law.

(iv) Notices and Registers.

Section 54.[82] (1) Every owner, proprietor, manager or other competent authority in charge of any factory, mercantile establishment, mill or work shop, commercial institution, establishment or other working place mentioned in this Act, shall serve on each inspector and each medical inspector for the inspection district in which such factory, mercantile establishment, mill or work shop, commercial institution or other establishment or working place is situated, a written notice, the name thereof, the place where it is situated, the nature of the work, and the nature and the amount of the moving power therein, and also the name of the person, firm or corporation under which the business of such factory, mercantile establishment, mill or work shop, commercial institution or other establishment or working place, is carried on; and shall state the address to which mail and other communications are to be addressed. Every such notice, when received by an inspector or medical inspector, shall forthwith be forwarded by him to the Department.

(2)[82] In case of a violation of this section, the person guilty of the violation shall be fined not to exceed twenty-five dollars for each offense.

Section 55.[83] The owner, proprietor, manager or other competent authority of every factory, mercantile establishment, mill or work shop, commercial institution or other establishment or working place mentioned in this Act, shall, on such day as the Department shall direct in each year, send to the Department a correct return specifying, with respect to such period, the number of persons in the factory, mercantile establishment, mill or work shop, commercial institution or other establishment or working place, such particulars as to the age, sex and occupation of the persons employed therein, and as to such other matters as the Department may direct; and in default of complying with this provision shall be liable to a fine not to exceed fifty dollars.

[82] *Ibid.*, p. 175, V, sub-sections (1), (2), of Sec. 127.
[83] *Ibid.*, p. 176, sub-section (1) of Sec. 130.

(v) Enforcement of This Act.

Section 56.[84] (1) It shall be the duty of the Chief and of the Assistant Chief of the Department and of the inspectors and medical inspectors under the direction and supervision of the Chief of the Department, to enforce the provisions of this Act, and to prosecute all violations thereof before any magistrate or before any court of competent jurisdiction in this State.

(2)[84] It shall be the duty of the State's Attorney of the proper county, upon request of the Chief or the Assistant Chief of the Department, or of any inspector or medical inspector thereof, to prosecute any violation of law that it is made the duty of the Chief and the Assistant Chief of the Department and the inspectors and medical inspectors to enforce.

(vi) Reports.

Section 57.[85] (1) The Department shall report in writing to the Governor, on the fifteenth day of December annually, the result of its inspections and investigations, together with such other information and recommendations as it shall deem necessary, and such further particulars as the Governor may require; and

(2) The inspectors and medical inspectors shall make a special investigation into the conditions of labor, or into any alleged abuses in connection therewith, as related to the subject matter of this Act, whenever the Governor shall direct, and shall report the result thereof to the Department, which shall thereupon make report of the same to the Governor; and

(3) The inspectors and medical inspectors, or any of them, shall make investigations and perform such other acts in such manner and at such times as the Department shall direct, and shall report the results of such investigations and of their acts in relation thereto to the Department.

PART V.

Legal Proceedings.

Section 58.[86] (1) If a factory, mercantile establishment, mill or workshop, laundry, foundry, bakery, commercial institution, or other establishment or working place mentioned in this Act, is not kept in conformity therewith, the owner, proprietor, manager, or other competent authority thereof, and in the cases mentioned in (a), (b), (c) of section 41, Part III of this Act, the owner of the building and premises or either of them on or in which any factory, mechanical establishment, mercantile establishment, mill or workshop, laundry, foundry, bakery,

[84] Factory Inspection Act, 1907, Hurd's *Rev. Stats. Ill.*, p. 1098, Sec. 77, portions only of said section.

[85] *Ibid.*, portions of the section last cited.

[86] Taken from English Factory and Workshop Act, 1901, 2 Butt., p. 177, Part IX, sub-sections (1) and (2) of Sec. 135, and adapted to conditions here.

commercial institution, or other establishment or working place, is situated, shall be liable to a fine not exceeding twenty-five dollars, and in case of a second or subsequent offense not less than twenty-five dollars for each offense.

(2) Any Justice of the Peace or court of competent jurisdiction that has under the law jurisdiction of the person or persons and subject matter of this section may, in the cases provided for in subsection (1) of this section, in addition to or instead of imposing a fine, order such means to be adopted by the person fined and any other person or persons, or any one or any of them, as the court may determine, that are under legal obligation to comply with the provisions of this Act with respect to the subject matter of the offense, within the period named in the order, for the purpose of bringing the factory, mercantile establishment, mill or workshop, laundry, foundry, bakery, commercial institution, or other establishment or working place named in said subsection, into conformity with this Act, the Court may on application enlarge the time so named; but if, after the expiration of the time originally named and enlarged by a subsequent order, the order is not complied with, the person convicted and any other person or persons, or any one or any of them, named in said order shall be liable to a fine not exceeding five dollars for every day in which non-compliance continues.

Section 59.[87] (1) In case of an offense in which the owner, proprietor, manager, or other competent authority of any factory, mechanical establishment, mercantile establishment, mill or workshop, laundry, foundry, bakery, commercial institution, or other establishment or working place, or for which the owner of the building or buildings and premises, or either of them, of such establishment or working place aforesaid, is liable under this Act to a fine, has in fact been committed by an agent, servant, employee or other person, that agent, servant, employe or other person shall be liable to a fine as if he were the owner, proprietor, manager, or other competent authority thereof, or of the owner of the building or buildings and premises, or either of them, as aforesaid.

Section 60.[88] (1) In case the owner, proprietor, manager, or other competent authority of any factory, mercantile establishment, mill or workshop, laundry, foundry, bakery, commercial institution, or other establishment or working place, or owner of the building or buildings and premises, or either of them, on or in which any of the before named establishments or working places are situated, is charged with an offense against this Act, he shall be entitled, upon complaint duly made by him, to have any other person or persons that he charges as the actual offender or offenders brought before the court at the time appointed for the hearing of the charge; and if, after the commission of the offense has been proved, the said owner, proprietor, manager, or other competent authority, or the owner of the building or buildings and premises, or either of them aforesaid as the case may be, originally charged with such offense, proves to the satisfaction of the court:

[87] *Ibid.*, p. 179, Sec. 140.
[88] *Ibid.*, p. 180, Sec. 141, sub-section (1) (a), (b) and sub-section (2).

(a) That he has used due diligence to enforce the execution of this Act; and

(b) That the said other person or persons had committed the offense in question without his knowledge, consent or connivance, that other person or those other persons shall be convicted of the offense, and the owner, proprietor, manager, or other competent authority aforesaid, or the owner of the building or buildings and premises, or either of them, as the case may be, as aforesaid, shall be exempt from any fine. The person so convicted shall, in the discretion of the court, also be liable to pay any costs incidental to the proceeding.

PART VI.

Supplementary.

(i) Applications and Definitions.

Section 61.[89] (1) Subject to the provisions of this section, the following words and expressions have in this act the meanings assigned to them, that is to say:

(a) Bakery. The word "bakery" in this Act shall include all buildings, rooms, or places in which bread, biscuits, pies, crackers, cakes, and other articles usually manufactured therein, and confectionery, are made or manufactured; and all buildings, rooms, or places in which said articles are kept for sale.

(b) Child. A person is a "child," in the meaning of this Act, until he or she has completed his or her fourteenth year.

(c) Commercial Institution. "Commercial Institution," in the meaning of this Act, is any place or premises where articles are bought and sold or either, stored or kept for use, not a "mercantile establishment" as defined in this Act.

(d) Factory. "Factory," in the meaning of this Act, is any place or premises wherein or whereon electricity, steam, water or other mechanical power is used to move or work any machinery employed in preparing, manufacturing or finishing, or any process incident to the manufacturing of any article or part of any article; or the altering, repairing, ornamenting or the adapting for sale of any article.

(e) Foundry. "Foundry," in the meaning of this Act, is any building, works or premises on or in which the act, process or art of casting metals is carried on.

[89] The method of the English Act of defining terms is followed in this section. 2 Butt., *Twent. Cent. Stats.*, Factory and Workshop Act, 1901, p. 183 ff (i), Sec. 149 ff.

(f) Gassing. "Gassing," in the meaning of this Act, is the inhaling of deleterious gases, especially those affecting plumbers, tailors, conduit men, coal miners and workers at blast furnaces and in illuminating gas works and other similar occupations.

(g) Manager. "Manager," in the meaning of this Act, is any person in charge or control of or directing the business affairs of any factory or other business establishment or part thereof.

(h) Mercantile Establishment. The term "mercantile establishment," in the meaning of this Act, includes all concerns or places where goods, wares, or merchandise are purchased or sold, either at wholesale or retail.

(i) Mill or Workshop. The term "mill or workshop," in the meaning of this Act, includes any premises, room or apartment not being a factory as above defined, wherein any labor is exercised by way of trade or for the purpose of gain in or incidental to any process of making, altering, preparing, cleaning, repairing, ornamenting, finishing or adapting for sale any article or part of any article, and to which or over which building, premises, room or apartment, the employer of the person employed or working therein has the right of access or control; but said term does not apply to a private house or private room in which manual or other labor is performed by a family dwelling therein, or by any of them for the exclusive use of the members of such family.

(j) Other Establishment or Working Place. "Other establishment or working place," in the meaning of this Act, is any place or premises in or on which any occupations contemplated in this Act are carried on, not included in the terms: factory, mercantile establishment, mill or workshop, and any place or premises not named in this Act and any other place or premises when not specifically named in certain provisions in this Act, but named in certain other provisions thereof, to which any or all of the aforesaid places or premises the provisions of this Act can be applied.

(k) Owner. "Owner," in the meaning of this Act, is any person that carries on any business or occupation in any factory, establishment or working place under this Act, and who has the legal or rightful title thereto. A person may at the same time be "owner" as just defined and also "owner" of a building, buildings and premises or either, as the latter expression is used in this Act.

(l) Proprietor. "Proprietor," in the meaning of this Act, is a person who has the legal right or exclusive title to the business carried on in any factory or other establishment or working place under this Act.

(m) Young Person under the Age of Sixteen Years. A "young person under the age of sixteen years," in the meaning of

this Act, is a person that has ceased to be a "child," as defined in this Act, and has not completed his or her sixteenth year.

(n) Young Person. A "young person," in the meaning of this Act, is a person that has ceased to be a young person under the age of sixteen years, as defined in this Act, and has not completed his or her eighteenth year.

(o) Woman. A "woman," in the meaning of this Act, is a female that has ceased to be a "young person," as defined in this Act.

(2)[90] A place or premises as used in this Act shall not be excluded from the definition of a factory, mercantile establishment, mill or workshop, commercial institution, foundry, laundry, bakery, or other establishment or working place coming within the provisions of this Act, by reason only of the fact that the place or the premises is or are in the open air.

(3)[91] For the purposes of this Act an apprentice shall be deemed to work for hire or wages.

Section 62.[92] For the purpose of disseminating a general knowledge of the provisions of this Act among employees, the Department of Labor shall have prepared a notice covering the salient features of this Act, which may be in the following form:

NOTICE TO OWNERS AND EMPLOYEES OF MERCANTILE ESTABLISHMENTS, FACTORIES, MILLS AND WORKSHOPS.

This notice must be posted in a conspicuous place, in every office and room of this establishment. The object of this notice is to promote the health, comfort and safety of employees, and requires their attention and co-operation.

(a) The premises must be kept in a clean and sanitary condition.

(b) Ample and separate toilet facilities for each sex shall be provided, and toilet rooms must be kept clean, well ventilated and well lighted.

(c) Food must not be taken into any room where white lead, arsenic or other poisonous substances or gases are present under harmful conditions.

(d) Poisonous and noxious fumes or gases, and dust injurious to health, arising from any process, shall be removed as far as practicable.

The notice shall be printed on card board of suitable character, and the type used shall be such as to make it easily legible. In addition to English, this notice shall be printed in such other languages as may

[90] English Act, 2 Butt., Sec. 149, p. 184, sub-section (5).
[91] *Ibid.*, p. 185, Sec. 152, sub-section (1).
119, only those portions used that could be applied to the provisions of this draft.
[92] Taken from the Health, etc., Act, 1909, Hurd's *Rev. Stats. Ill.*, p. 1108, Sec.

be necessary to make it intelligible to employees. Copies shall be supplied by the State Department of.....on application, and must be posted in a conspicuous place in every office and work room of every establishment covered by the provisions of this Act.

Section 63. This Act may be cited as: THE PUBLIC HEALTH OCCUPATIONS ACT.[93]

Section 64. All Acts or parts of Acts inconsistent with *this* Act are hereby repealed.

Section 65. This Act shall come into operation on the first day of July, of the year One Thousand Nine Hundred and Eleven.

Protective Legislation in the United States.

AIR-SPACE.

In those states having provisions relating to the subject of air-space the number of cubic feet for each person is usually 250 cubic feet from the hour of 6 a. m. to 6 p. m., and 400 cubic feet from the hour of 6 p. m. to 6 a. m. The following states have such provisions:

Indiana: Ann. Stats. of 1894—Revis. 1901, Sec. 70870; and see 22nd Annal. Rept. of U. S. Commissioner of Labor, 1907, Labor Laws of the U. S., Govt. Print. Office, Washington, D. C. 1908, C. II, p. 400.

Maryland: Code of 1903, Art. 27, Sec. 238.

Michigan: Acts of 1901, Act No. 113, Sec. 17, as amended by Act No. 169, Acts 1907.

New Jersey: Acts of 1904, C. 64, Sec. 19.

Pennsylvania: Brightly's Dig. 1893-1903, p. 825, Sec. 2; Acts 1905, Act. No. 226, Sec. 13.

Wisconsin: Ann. Stats. 1898, Supplt., 1906, Sec. 1636-71, par. 4.

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[93] Or any other title appropriate to the subject-matter of any Act framed with the objects in view set forth in this draft, which is intended to be suggestive of provisions that might be inserted in a Bill rather than as presenting such a Bill for legislative action.—Albert J. Norton.

The English Act, which has served largely as a model for the foregoing draft, has appended to it several "Schedules," with provisions relating to arbitrators, overtime, in certain kinds of business—readings of thermometers, etc., and a table of Acts and parts of Acts repealed. Such schedules contain many useful regulations that, if introduced into the body of the Act, would somewhat break up its continuity.

States having additional regulations:

Arizona: Laundries must afford 600 cubic feet of air to each worker in a room. See Legisl. Review No. 1, Am. Assn. for Labor Legislation—Review of L. Legisl. of 1909, by Irene Osgood, Asst. Secy. Am. Assn. for Labor Legisl. New York, 1910, p. 21.

New York: From 6 a. m. to 6 p. m., 250 cubic feet, and from 6 p. m. to 6 a. m., 400 cubic feet, unless the factory inspector grants a permit for less than 400 c. feet to each person. Rev. Stats. of 1901, 3rd ed., Sec. 85, under inspection of factories and workshops, p. 2102.
Sec. 100 (as amend. by C. 129, Acts of 1906), applying to tenement house, or any part thereof, used as a factory for workers in cloths, etc., ice cream, confectionery, nuts, etc., requires 500 cubic feet of air-space for each person, and the whole number of persons in a room is not to exceed 1 person to each 1,000 cubic feet of air-space.

Cleanliness.

The majority of those states having provisions of law covering this subject require that factories, etc., shall be kept as clean as the nature of the business will permit.

The states with laws relating to the subject are given below:

Connecticut: Genl. Stats. of 1902, Sec. 4527 and 4529, relating to "sweat-shops."
Genl. Stats. of 1902, Sec. 4516, relating to factories and buildings in which machinery is used.

Iowa: Code of 1897, Supplt. of 1902, Sec. 499a.

Kentucky: Acts of 1906, C. 52, Sec. 7.

Maryland: Carroll County; Code 1903, Art. 27, Sec. 234.

Massachusetts: Rev. Laws of 1902, Sec. 41, as amend. by C. 503, Acts of 1907.

Oregon: Acts of 1907, C. 158, Sec. 2.

Pennsylvania: Acts of 1905, Act No. 226, Sec. 13.

Tennessee: C. 401, Acts of 1899, C. 67, Acts of 1901, Supplt. p. 470, Sec. 3.

Washington: Acts of 1905, C. 84, Sec. 2.

Wisconsin: Ann. Stats. of 1898, Supplt. 1906, Acts of 1907, Sec. 1636-34.

States Having Additional Regulations:

Missouri: Provides for limewashing or painting, at least once in every 12 months in all factories and workshops in which "dusty

work" is carried on where women and children are employed. Rev. Stats. 1899, Sec. 6438.

New Jersey: Acts of 1904, C. 64, Sec. 24. Similar to law of Missouri.

New York: Rev. Stats. of 1901, 3rd ed. p. 2106, Sec. 84.

The limewashing or painting is to be done whenever the factory inspector thinks it conducive to the health and cleanliness of the person working in a factory, etc.

Sanitation.

The general tenor of the provisions in the laws of those states that have taken legislative action on the subject of sanitation in factories, etc., is to the effect that the premises shall be kept in a clean and sanitary condition. Some of the states also provide that there shall be hot and cold water for the use of employees.

Some states add to the foregoing particulars provisions that there shall be toilets for men and women with separate approaches, and also that they shall be screened and kept free from obscene writing and marking.

Here follows a list of states with laws on this subject:

Connecticut: Genl. Stats. 1902, Sec. 4519—Factories. Genl. Stats. 1902, Sec. 4527, Sec. 4529; Sec. 2569 as amended by C. 13, Acts of 1905—Sweatshops. Acts of 1905, C. 140, Sec. 1—Foundries.

Delaware: Acts of 1897, C. 452, Sec. 1, as amended by C. 452, Acts of 1897.

Indiana: Ann. 1894, Revis. 1901, Sec. 7087j, under factories and workshops—Inspection, etc.

Iowa: Code of 1897, Supplt. 1902, Sec. 4999a.

Kentucky: Acts of 1906, C. 53, Sec. 5.

Louisiana: Act 34 of Acts of 1906, Sec. 4.

Maine: Rev. Stats. of 1903, C. 18, Sec. 44, as amended by Acts of 1907, C. 77.

Maryland: Code of 1903, Act. 27, Sec. 234.

Massachusetts: Revis. Laws, 1902, C. 106, Sec. 47—Factories. Acts of 1906, C. 250, Sec. 1—Foundries.

Michigan: Acts of 1901, Act. 113, Sec. 10, as amended by Act 169 of Acts of 1907.

Minnesota: Revis. Laws of 1905, Sec. 1818.

Missouri: Rev. Stats. 1899, Sec. 10100. Rev. Stats. 1899, Sec. 6441.

New Jersey: Acts 1904, C. 64, Sec. 23.

New York: Rev. Stats. 1901, Sec. 168. Rev. Stats. 1901, Sec. 88, as amended by C. 485, Acts of 1907.

Pennsylvania: Brightly's Dig. 1893-1903, p. 865, Sec. 21. Acts of 1905, Act No. 226, Sec. 13. Acts of 1905, Act. No. 226, Sec. 8.

Washington: Acts of 1905, C. 84, Sec. 82.

Wisconsin: Ann. 1898, Supplt. 1906, Acts of 1907, Sec. 1636-34.

States Having Additional and Exceptional Regulations:

District of Columbia: Acts of Congress, 1898, C. 8, Sec. 9. Owner of a building in which any trade or business is carried on must provide suitable privy accommodations for employes of each sex. Unlawful for owner or agent or such building to put any person in possession thereof or of any part thereof unless provided with such accommodations.

Kentucky: Acts of 1906, C. 53, Sec. 5. Dressing rooms to be provided in factories, etc., for women and girls, where required by the Labor Inspector.

Ohio: Bates' Ann. Stats. 3d Ed. Sec. 4364-69. The owner of a factory, etc., must provide suitable toilet rooms for women employees in the manner specified. Has regulations as to such toilets in towns or villages that do not have a system of water works, unless building is provided with a dry closet system.

Seats for Women.

The usual provisions on the subject of seats for women in mercantile establishments, etc., are that the employer shall furnish female employes with a sufficient and suitable number of seats and shall permit the use of them when such employees are not necessarily engaged in the active duties for which they are employed. In some cases the minimum number of seats to be furnished is specified.

The laws of some states include hotels, restaurants and warehouses in the list of establishments in which seats are to be provided.

The states having provisions of the character just indicated are named below:

Alabama: Code of 1897, Sec. 5512. Code of 1907, Sec. 6857.

California: Codes and Stats. of 1885, Supplt. of 1889, Sec. 5, as amended by C. 12, Acts of 1903.

Colorado: Mill's Ann. of 1891, Sec. 3604.

Connecticut: Genl. Stats. of 1902, Sec. 4703.

District of Columbia: Acts of Congress, 1894 and 1895, C. 192. Sec. 1.

Florida: Genl. Stats. 1906, Sec. 3235.

Georgia: Vol. 3, Penal Code, Div., Sec. 127.

Iowa: Code of 1897, Supplt. 1902, Sec. 4999.

Kansas: Genl. Stats. of 1901, Sec. 3842.

Kentucky: Acts of 1906, C. 52, Sec. 6.

Louisiana: Acts of 1906, Act 34, Sec. 3.

Maryland: Code of 1903, Act 27, Sec. 147a, as amended.

Massachusetts: Comp. Laws of 1897, Sec. 5373.

Minnesota: Rev. Laws of 1905, Sec. 1802.

Missouri: Rev. Stats. of 1899, Sec. 6443.

Nebraska: Comp. Stats. of 1881, 10th Edit. 1901, Sec. 6942c.

New Hampshire: Acts of 1895, C. 16, Sec. 1.

New Jersey: Genl. Stats. 1895, Vol. 2, p. 1675, Sec. 217.

New York: Rev. Stats. of 1901, p. 2053, Art. I, Labor. Sec. 17, Ibid, 170, Art XI, Labor.

Ohio: Bate's Ann. Stats., 3d Edit., Sec. 4364-69.

Ventilation.

The ordinary provisions on the subject of ventilation range from a few words in the language of the statutes of some states to a specification of considerable length in that of other states as to the methods and devices to be used in order to secure proper protection in this respect. The principal points are named in the following paragraph.

The premises must be kept well ventilated or sufficiently ventilated. The longer provisions may be conveniently stated in the following terms: In factories, etc., in which a work or process is carried on by which dust, filaments or injurious gases are generated or produced, that are likely to be inhaled by the employees therein, the proprietor of the factory must provide an exhaust fan or blower and pipes, and hoods extending therefrom to each wheel or other apparatus used to grind, polish or buff metals; such fan or blower and pipes and hoods are to be properly adjusted and of sufficient power and dimensions to prevent the dust and filaments, arising in the manner specified, from escaping into the rooms of such factory where the employed work, and the ventilation must be of such a character that the air does not become exhausted and that the injurious gases, fumes or vapors generated are rendered harmless.

The laws of those states having provisions of the kind mentioned are cited below:

California: Codes and Stats. 1885, Supplt. of 1889, Sec. 4, as amended by C. 176, Acts of 1901; ibid., Sec. 2.

Connecticut: Genl. Stats., Sec. 4521.

Indiana: Ann. 1894, Revis. 190, Sec. 7087.

Iowa: Code 1897, Supplt. 1902, Sec. 4999c.

Maryland: Acts of 1894, C. 202, Sec. 1.

Carroll County: Code of 1903, Art. 27, Sec. 234.

Massachusetts: Acts of 1903, C. 475, Sec. 4; ibid., 1, 2, 3; Revis. Laws of 1902, C. 106, Sec. 51.

Michigan: Acts of 1899, Act No. 202, Secs. 1, 2, 3, 4; Acts of 1901, Act No. 113, Sec. 9; Acts of 1907, Act No. 152, Sec. 3.

Minnesota: Revis. Laws of 1905, Sec. 1814.

Missouri: Rev. Stats. of 1899, Sec. 6444; ibid., 10101, 10102; ibid., 6442.

New Jersey: Acts of 1904, C. 64, Secs. 14, 15, 16, 17, 20.

New York: Rev. Stats. of 1901, Sec. 81; ibid., Sec. 86 as amended by C 490, Acts of 1901.

Ohio: Bates' Ann. Stats. 3d Ed. 4364-86, 4364-87, 4364-88, 4364-89.

Oregon: Acts of 1907, C. 158, Sec. 2.

Pennsylvania: Brightly's Dig. 1893-1903, Sec. 11, Sec. 14.

Washington: Acts of 1905, C. 84, Sec. 2.

Wisconsin: Ann. Stats. 1898, Supplt. 1906, Secs. 1636-33, 1636-39, 1366-41, 1636-42, 1636-61.

Additional and Exceptional Regulations.

Arizona: The provision applies to laundries. Every room must have at least two outside windows arranged so as to give a cross current of air.—Legis. Rev. No. 1, Am. Assn. for Labor Legisl. Rev. of L. Legisl. of 1910, etc., p. 21.

Massachusetts: The law applies to factories, etc. The water used for humidifying shall be pure. Dept. Com. & Labor Bulletin of the Bureau of Labor, No. 81, Mch. 1909, p. 46, Acts of 1908, C. 325, Sec. 1.

New York: "The 1907 law regulating underground work provided for a proper head and trap doors; but the law of 1909 adds that work in compressed air as in tunnels and caissons must be carried on under the following conditions:

Air Pressure Lbs. to the sq. inch	*Hours Employed.*	*Intervals in open air between work periods.*	*Rate of compression on workmen in outgoing locks.*
Normal to 28 lbs.	8	½ hour.	3 lbs. every two minutes.
28 lbs. to 36 lbs.	6, in two 3 hr. periods.	1 "	"
36 lbs. to 42 lbs.	4, in two 2 hr. periods.	2 "	1 lb. per min.
42 lbs. to 46 lbs.	3, in two 90 min. p'r'ds.	3 "	"
46 lbs. to 50 lbs.	2, in two 1 hr. periods.	4 "	"
50 lbs. +	Only in emergencies.		

"One or more qualified medical officers must examine employes, before they begin work, after an absence of three successive days, and again after three months' employment. New employees may work only half time on the first day, after which they must be re-examined.

"Any one addicted to the excessive use of intoxicants is refused employment. The medical officer must keep a complete record of all examinations, and must see that properly equipped dressing-rooms and a medical lock are maintained. Minimum penalty, $250 or one year's imprisonment, or both. The law goes into effect Jan. 1, 1910. (C. 291.)"

See Legisl. Rev. No. 1, etc., cited above under Arizona, pp. 22, 23.

For all labor legislation in this Country, see:

Twenty-second Annual Report of the U. S. Commission of Labor, 1907, Labor Laws of the United States, and the later Bulletins of U. S. Bureau of Labor.

Foreign Legislation and Administrative Regulations.

Note by the Secretary.

Translations have been made by the Secretary and his assistants of relevant laws and regulations of the principal European countries, and these have been consulted in the preparation of this Report. But they could not be published in proper form at present, and mere extracts would give a misleading idea of their scope and contents, therefore all this material is omitted.

PHOSPHORUS

For information on one of the most serious occupational diseases we reprint some extracts from a paper published by the Bureau of Labor: "Phosphorus Poisoning in the Match Industry in the United States, by John B. Andrews, Ph. D." Bulletin of the Bureau of Labor, No. 86, January, 1910.

Introduction.

Those who have followed the results of studies of the conditions surrounding industrial employments with reference to the effect upon the health of the employees are impressed by the possibilities of a scientific movement to improve working conditions and reduce occupational dangers. The manufacture of matches in the United States beyond any other industry presents an opportunity to improve conditions and easily to make a most dangerous industry entirely harmless. Peculiar to this industry is a disease, which, without great expense, without a long struggle against poverty, indifference, ignorance, and neglect, may be absolutely eliminated by the prohibition of the use of white phosphorus. This disease, known to the medical and dental professions as phosphorus necrosis, continually threatens those who work in match factories where poisonous phosphorus is used. The phosphorus most frequently attacks the jaw bones, and sometimes necessitates the removal of an entire jaw by surgical operation. A harmless substitute for the poison that is commercially practicable is readily available. Why, then, do our manufacturers not use this substitute? Many would gladly do so, but it costs just a little more to make the nonpoisonous matches. Competition is so keen that a single manufacturer can not place himself at a natural disadvantage with his rivals in business.

In the leading countries of Europe the governments have come to the aid of both workers and manufacturers by requiring all manufacturers to discontinue the use of the poison. In these countries the manufacturers are all on an equal footing in competition and the danger of phosphorus poisoning is entirely eliminated (p. 32).

Processes of Manufacture and Phosphorus Poisoning.

Although complicated by modern methods and machines, the fundamental processes in the manufacture of matches may be described in a few words. The wooden match splint is prepared; the phosphorus composition for the head of the match is mixed; one end of the splint is dipped into this paste; the "green" match is allowed to dry; and finally it is boxed and wrapped.

The processes which are especially dangerous in this industry are all those which bring the employee within range of the poisonous phosphorus. In the mixing, dipping, drying, and packing rooms the danger from breathing the phosphorus fumes and from contact with the phosphorus is always present, although it may be much diminished by thorough ventilation and by the rigid enforcement of preventive measures. Also particles of phosphorus become attached to the hands and later are transferred to the mouth by the employees.

Poisoning from phosphorus has many evil effects. Some are local, others general. The general effect most frequently noted in cases of chronic poisoning is anæmia. The daily breathing of the air laden with phosphorus fumes and continual contact with the particles of phosphorus result in a gradual lowering of vitality, which in turn invites other forms of disease. This is one of the most prevalent and most serious results of phosphorus poisoning. But such general effects are much more difficult of actual determination, and consequently the local effects, which are most conspicuous, receive the greater attention.

Phosphorus necrosis, the peculiar local form of the disease, is caused by the absorption of phosphorus through the teeth or gums. The generally accepted theory is that minute particles of the poison enter, usually, through the cavities of decayed teeth, setting up an inflammation which, if not quickly arrested, extends along the jaw killing the teeth and bones. The gums become swollen and purple, the teeth loosen and drop out, and the jaw bones slowly decompose and pass away in the form of nauseating pus, which sometimes breaks through the neck in the form of an abscess or, if not almost continually washed out, oozes into the mouth where it mixes with the saliva and is swallowed.

Treatment is largely preventive, but when the disease is once established a serious surgical operation is often the only means of arresting the process of decay. In many instances of poisoning it is necessary to remove an entire jaw, and in several cases both jaws have been removed at a single operation. A number of cases of necrosis have resulted in death.

It is the awfulness of this disease and the ease with which it can be prevented that has led many countries, where the effects of the disease and the means for its prevention have been studied, to do away with the disease forever.

Two kinds of phosphorus are used in the manufacture of matches. One is the red or amorphous variety contained in the friction surface of safety-match boxes. This, when pure, is entirely harmless. It is made by baking in a closed vessel the poisonous or white (yellow) phosphorus, and is consequently more expensive. The poisonous phosphorus is made from bones, and when sold for commercial purposes is usually in the form of sticks in appearance not unlike lemon candy. A very small amount of this poison is sufficient to cause death.

Broadly speaking, three kinds of matches are manufactured. One is the "safety" match, which must be struck on a prepared surface on the box. This match contains no phosphorus and is harmless. The igniting composition is painted on the box and contains red phosphorus which, when pure, is nonpoisonous. Although used almost exclusively in one or two countries of Europe, their manufacture in this country is still very limited, and requires no more than passing comment.

The second kind of match can be struck on any ordinary rough surface, and is called the "strike-anywhere" phosphorus match. This is the familiar parlor match. As made in America, the paste for the head of this ordinary match contains poisonous phosphorus, which is the cause of the peculiar occupational disease, phosphorus necrosis, among workers

in match factories. The use of this poisonous element is now prohibited in the leading civilized countries of the world, but no special action has yet been taken for the protection of working people in this country.[1]

The third variety of match also possesses the desirable quality of striking anywhere, and is at the same time nonpoisonous. This is the strike-anywhere match, now manufactured and used in those countries where public sentiment has been sufficiently aroused to prohibit the use of the white phosphorus in match making. In France, where the substitute for white phosphorus was discovered and where it was first used, the match business has been a government monopoly for more than twenty years, and as such threw upon the government the burden of bearing the human loss resulting from the peculiar hazards of the industry. French government officials noticed that the profit they had hoped to receive from this business was rapidly drawn away in the form of compensation for sickness and death from phosphorus poisoning. Experts were set to work to find a substitute for the poisonous element, and they found it in the sesquisulphide of phosphorus. For twelve years, in France, this substance has been successfully employed, and its use has been extended to several other countries, which have absolutely prohibited the manufacture, importation, and sale of matches made from white phosphorus. (Pp. 39-42.)

Description of Factory at ———, Illinois.

This factory was established seven years ago. Square-end parlor matches are made. The mixing of the chemicals used in making composition of heads for matches is done in a small detached building. The dipping, drying, and the packing and wrapping are done in separate rooms.

The dipping room has five machines, which operate automatically. They consist, essentially, of a series of wheels over which a continuous belt travels. This belt is made of about 800 plates joined together. Each plate has 600 perforations—that is, twelve rows of 50 each. At one point in its transit each plate passes in front of a hopper, into which the trays of splints are emptied. An automatic punch strikes the splints, forcing them into the holes in the plate. This punch operates at the rate of from 225 to 250 times per minute. As the belt moves, each plate, with its load of splints, passes over a vat of molten paraffine, into which the splints are dropped to a depth of about one-quarter of an inch.

A little beyond the paraffine vat is the composition pot. This contains the material which forms the striking head of the match. The paraffined splints are coated at one end with this composition by means of slowly revolving rollers, which bring up an even amount of composition. For the ordinary parlor match one dipping is sufficient. For the so-called

[1] At the time of this investigation only one State—Ohio—had any specific provision restricting the employment of children in match factories. More recently several other States—New York, Pennsylvania and Oklahoma—have endeavored to prevent employers from using children of tender years in match manufacture, but the administration of these provisions offers no adequate protection for older workers. In one State visited the chief factory inspector or his chief clerk were unaware of the existence of two match factories in their State, although the factories were not new.

double-tipped matches there is a second composition pot, with a different kind of material, into which the tip of the match is dipped.

After dipping, the matches traverse a distance of about 250 feet before they again return to their starting point. Just before reaching the splint hopper the matches are automatically punched out of the plates, falling on a moving belt, which carries them to the packers. The packers are all women, who place the matches in paper boxes holding from 120 to 1,000 each. One machine is fitted with an automatic packing device. The boxes are fed into the machine and come out filled, the packing in this case requiring only the putting on of the cover. After the matches have been packed, the boxes are wrapped in packages of one dozen and placed in wooden cases.

The ventilation is by the windows and doors only. On first entering the room the agent's eyes were considerably irritated and kept smarting for some time. It was observed that the eyes of the employees in the dipping room appeared to be sore and irritated.

Fumes are noticeable in all of the working rooms. In the dipping and drying room, fumes from the composition and from the burnt or burning matches were strong. So hazy is the air at times from smoke from the burning matches that one can scarcely see objects 10 feet off. There are no appliances for removing the fumes.

Washing accommodations are poor and facilities are insufficient. The only provision for washing is a faucet in the yard.

Before employing any person in any of the rooms where they are liable to be affected by the chemicals used, the company requires an examination of the individual's teeth by its dentist. No one is employed unless the dentist certifies the teeth to be in good condition. While the company pays for the examination, the employee must pay for any necessary dental work. There are also quarterly examinations of the employees' teeth by the dentist. If it is found that anyone's teeth are in need of treatment, such person is not permitted to return to work until afer having had the defects attended to.

The agent observed that the lunch boxes were kept in the workrooms and that practically all of the employees ate their lunches in the factory.

The manager stated that in the seven years since this plant was established one serious case of necrosis had developed. The individual in question was an experienced employee who had worked in the mixing room for a number of years (p. 139).

British White Phosphorus Matches Prohibition Act, 1908.

Chapter 42. An act to prohibit the manufacture, sale, and importation of matches made with white phosphorus, and for other purposes in connection therewith. (December 21, 1908.)

1. (a) It shall not be lawful for any person to use white phosphorus in the manufacture of matches, and any factory in which white phosphorus is so used shall be deemed to be a factory not kept in conformity with the Factory and Workshop Act, 1901, and that act shall apply accordingly.

(b) The occupier of any factory in which the manufacture of matches is carried on shall allow an inspector under the Factory and Workshop Act, 1901, at any time to take for analysis sufficient samples of any material in use or mixed for use, and, if he refuses to do so, shall be guilty of obstructing the inspector in the execution of his duties under that act:

Provided, that the occupier may, at the time when the sample is taken, and on providing the necessary appliances, require the inspector to divide the sample so taken into two parts and to mark, seal and deliver to him one part.

2. It shall not be lawful for any person to sell or to offer or expose for sale or to have in his possession for the purposes of sale any matches made with white phosphorus, and, if any person contravenes the provisions of this section, he may, on complaint to a court of summary jurisdiction, be ordered to forfeit any such matches in his possession, and any matches so forfeited shall be destroyed or otherwise dealt with as the court may think fit, but this provision shall not come into operation as respects any retail dealer until the 1st day of January, 1911.

3. It shall not be lawful to import into the United Kingdom matches made with white phosphorus, and matches so made shall be included amongst the goods enumerated and described in the table of prohibitions and restrictions contained in section forty-two of the Customs Consolidation Act, 1876.

4. (a) Any person who is manufacturing or proposing to manufacture matches by way of trade may present a petition to the Board of Trade, praying for the grant of a compulsory license to use any process patented at the passing of this act for the manufacture of matches without white phosphorus, other than matches intended to strike only on a surface specially prepared for the purpose.

(b) The Board of Trade, after considering any representations that may be made by the patentee, as defined by the Patents and Designs Act, 1907, and any person claiming an interest in the patent as exclusive licensee or otherwise, and, after consultation with the secretary of state, may order the patentee to grant a license to the petitioner on such terms as the board may think just. The provisions of the Board of Trade Arbitrations, etc., Act., 1874, shall apply to proceedings under this section as if this act were a special act within the meaning of that act.

(c) An order of the board directing the grant of a license under this section shall, without prejudice to any other method of enforcement, operate as if it were embodied in a deed granting a license and made between the petitioner and the patentee and such other persons claiming an interest in the patent as aforesaid.

5. (a) This act may be cited as the White Phosphorus Matches Prohibition Act, 1908, and shall, except as otherwise expressly provided, come into operation on the 1st day of January, 1910.

(b) For the purposes of this act the expression "white phosphorus" means the substance usually known as white or yellow phosphorus" (p. 145).